NASA-TM-112399

Space Technology Interdependency Group

STIG Operations Committee
Programmatic Review Proceedings
Gilruth Recreation Center
NASA-Johnson Space Center
February 3-4, 1994

Space Technology Interdependency Group

STIG Operations Committee

Cochairs: Dr. Kumar Krishen, NASA
Dr. Richard Miller, Air Force

Proceedings of a Programmatic Review Meeting held at the
NASA-Johnson Space Center
Houston, Texas
February 3-4, 1994

National Aeronautics
and Space Administration

Contents

Section 1

Space Technology Interdependency

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483-0695

SPACE TECHNOLOGY INTERDEPENDENCY

As part of the Space Technology Interdependency Group (STIG) key activities, NASA and the Air Force are developing Technology Roadmaps aimed at providing a mechanism by which greater visibility and coordination can be achieved in U.S. inter-departmental activities and advances in the area of space technology development. These Technology Roadmaps are at a critical stage of development and will be a vital step to the implementation phase of technology transfer and future commercialization by private industry, as well as improving upon our own government operations. JSC has a vital role in this activity.

The STIG was established in May 1982 to identify and promote the pursuit of new opportunities for cooperative relationships between NASA and the U.S. Air Force Systems Command (AFSC). In addition, STIG is chartered to monitor ongoing cooperative activities and identify areas of overlap and duplication. The Air Force responsibility now is located in the Materiel Command after the reorganization of the Air Force became effective in 1991. The goal of STIG is to provide advocacy, oversight, and guidance to facilitate and encourage cooperative development programs and to avoid duplication of effort and resources on space technology activities. Three categories of programs have been defined by STIG to characterize interaction. The dependent program is the one in which a single set or subset of mutually constructed program goals is planned. Dependency connotes coordinated management, shared resources, and strong agency executive management support. An interdependent program is one in which some degree of overlap is stated in the Agency program and/or technical goals, as outlined in a jointly developed program plan. It is assumed that there are complementary synergistic results beneficial to the participating agencies. Independent programs are conducted by one agency, with minimal or no cooperation from other agencies.

In July 1992, the U.S. Army and Navy formally joined STIG and, in 1992, the participation was extended to the DOE, SDI0, and ARPA. The STIG was organized and is implemented by direction from a Steering Committee. The AF Materiel Command Deputy Chief of Staff for Technology, and the NASA Associate Administrator for the Advanced Concepts and Technology Office serve as co-chairpersons and are responsible for designating members to the Steering Committee. The Steering Committee currently has members from the Army, Navy, SDIO, ARPA, and DOE. Steering Committee members are from the Headquarters' executive staff to provide technical expertise needed for direction and evaluation of programs.

The STIG program is implemented through eight technical committees. These committees are established by the Steering Committee. The members are selected from participating field centers and laboratories. The co-chairpersons for the technical committees are nominated by members of the Steering Committee (SC) and approved by SC co-chairpersons.

The STIG Information Collection, Transfer, and Processing Committee's technical scope includes microwave and millimeter wave electronics, microelectronics, photonics and optical communications, image processing, sensors and coolers, and large optical systems. The Propulsion Committee deals with chemical boost, solid rockets, air breathing, chemical transfer, electric (solar and nuclear) propulsion, and reaction control. The scope of Flight Vehicle Systems Committee includes aerothermodynamics, aeromaneuvering, guidance, navigation and control, thermal protection systems, and vehicle synthesis and design concepts. The Space Structures Committee concentrates on structural dynamics/control, and structural concepts and materials. The Space Power Committee deals with solar power generation, energy storage, power management and distribution, nuclear energy, thermal management, and power beaming. The charter of Space Environments and Effects is in the following areas: vehicle environments-radiation, effluents, plasmas and fields, meteoroids and debris, and environmental effects materials, equipment and biological systems. The Operations Committee is focused on robotics and telepresence, automation and intelligence, human factors, life sciences, and space maintenance and servicing. The Flight Experiments Committee concentrates on experiments coordination and launch opportunities.

The STIG committees have the responsibilities to: (l) identify and characterize interdependent activities, (2) encourage interdependent programs, (3) interchange technical and programmatic information and share lessons learned, (4) identify critical voids and non-productive overlaps in technology programs, and (5) promote technology transfer to industry and academic institutions. In the 1990-91 time frame, STIG had a total of 93 cooperative programs shared by DOD and NASA. In 1992, this number exceeded 120 and involved other agencies in many of these projects. Substantial increases were realized in 1993.

We will briefly describe the implementation strategy for the STIG Operations Committee (SOC) to illustrate the organization and products that come from each of the STIG technical committees. The SOC is co-chaired by Dr. Kumar Krishen of the NASA Johnson Space Center and Dr. Richard Miller of the USAF Armstrong Laboratory. There are five subcommittees under SOC on the Robotics and Telepresence, Automation and Intelligent Systems, Human Factors, Life Sciences, and on-orbit guidance, navigation, and control. These five subcommittees are jointly co-chaired by technical experts from the two organizations, NASA and USAF. The membership of the SOC includes Army, Navy, DOE, and SDIO, in addition to NASA and the USAF. The SOC has 65 members. The members of SOC were nominated by their laboratories, research centers, or organizations and approved by SOC co-chairpersons and the STIG Steering Committee. The SOC conducts two meetings on a yearly basis to: (1) review operations R&T plans, resources and progress within NASA, DOD and DOE; (2) develop and maintain list and descriptions of current interdependent programs and encourage and recommend future interdependent programs; and (3) develop and review Technology Roadmaps for Inter-Agency projects. One key area of SOC work involves facilitating communication of R&T results in the operations area across agencies and various centers within these agencies involved in the operations R&T. This technical interchange is facilitated through STIG Operations, Applications and Research (SOAR) Symposium and Exhibition on a yearly basis. Seven such symposia and exhibitions have been held in the past. The SOAR features technical review of interdependent programs, identification of future interdependent programs and concerns. It includes industry and academia. The proceedings are published to document progress made in operations R&T. The

SOC activities include both ground and space operations. Another activity of SOC concentrates on providing interface with NASA, DOD, and DOE Operations Technology Thrusts and the remaining seven STIG technical committees. A SOC recent survey showed more than 50 projects being coordinated across agencies and many more on which active communications are continued on a periodic basis. Furthermore, SOC has been successful in modifying many project plans of DOD and NASA to effect enormous cost savings. The SOC has also linked the industry and academia in an active manner in the joint development of the identified and prioritized R&T technical areas.

The benefits of Space Technology Interdependency are numerous and can be summarized as follows: (l) increasing interagency communications at all levels; (2) creating national technology cohesiveness through interaction with industry and academia; (3) sharing of expertise and facilities across agencies, industry, and educational institutions; (4) avoiding undesired duplication and reinventing through sharing of lessons learned; (5) developing cost-effective approaches through interdependent programs; (6) facilitating the identification of technology requirements for specific applications; and (7) creating an environment to gain a substantial edge in international competitiveness thorough technology transfer.

JSC's efforts in support of STIG have been highly commended by Brig. Gen. Richard Paul, Deputy Chief of Staff for Technology, AF Materiel Command and Mr. Gregory Reck, Acting Associate Administrator for NASA Advanced Concepts and Technology Office.

Section 2

Agenda

AGENDA
SOC Programmatic Review Meeting, 3-4 February '94
Room 217, Gilruth Center
NASA JSC

Thursday, 3 Feb '94

11:45 am	Lunch	
12:30 pm	Welcome / Meeting Objectives / Admin Announcements	Dr. Richard Miller Dr. Kumar Krishen
	Introductory Remarks	Mr. Stan Sadin
1:00	New Robotic Activities at JPL	Dr. Charles Weisbin
2:00	Occupational & Micro Environmental Applications to Performance and Space Operations	Col. Gerald Krueger
2:45	NASA Kennedy Space Center Advanced Technology Program	Ms. Karen Thompson
3:15	Break	
3:30	USA SSDC Space Applications Technologies	Mr. Ron Dickerman
4:15	Info on SOAR '94	Mr. Robert Savely
4:30	Adjourn	
6:00	Social Hour	
7:00	Dinner	

Friday, 4 Feb. '94

8:00 am	Continental Breakfast	
8:30	General SOC Session	SOC Co-Chairs
9:00	NASA Operations Technology Development - A New Approach	Dr. Melvin Montemerlo
	Interactive discussion on new approach	SOC Committee
9:45	Technology Roadmaps	Mr. Jerry Elliott
10:00	Individual Subcommittee Meetings Robotics And Telepresence Automation and Intelligent Systems Human Factors Life Sciences	SOC Subcommittee Co-Chairs
11:00	General SOC Session and Recap	SOC Co-Chairs
12:00 noon	Adjourn	

Section 3

Minutes from SOC Meeting

SOC PROGRAMMATIC REVIEW MEETING

February 3 and 4, 1994

Dr. Krishen opened the first day of the SOC Programmatic Review Meeting with the following announcement: Because there are several outstanding questions and to understand road maps better, Mr. Stan Sadin (NASA Headquarters) has been asked to talk to the group by telecon. Dr. Krishen identified Mr. Sadin as the NASA secretary for the STIG Committee; Col. Dionne is his Air Force counterpart. Mr. Greg Reck is the NASA cochairman; Dr. Schell is his Air Force counterpart. When action items are levied on the technical committees, Dr. Krishen explained, Mr. Sadin must pursue them to their completion.

Text of Mr. Sadin's comments is transcribed below:

We're part of the executive committee, or steering committee, of the STIG to which each of the technical committees reports. The STIG has been around for a number of years. During that time, it's been through several different incarnations. It started out as a fairly informal system; it was just an occasional exchange once a year without a formal agenda or a technical structure. It then became formalized and developed into a system of technical committees – very much a bottoms-up kind of organization – that was grass roots in nature and founded on a belief that, because working knowledge is held by the people in the laboratories, this is where interdependency should take place. From its inception the charter of the STIG has been to avoid nonproductive overlaps between Government agencies involved in space research, and to identify voids where concerted action would lead to solving voids in critical areas of technology need.

For the most part, STIG has had a somewhat passive approach to interdependency. A lot of time has been spent on that word interdependency. Interdependency does *not* mean dependent. We must not have one program dependent on another program, so that with the demise of one program both programs go under. Instead we must have programs which are closely coupled with well-coordinated systems and with the understanding that the effect of the sum of the two parts is greater than the algebraic sum of the whole. STIG has been operating that way for several years.

What's been developing over the last couple of years is a shrinking of budget – especially on the DOD side and also, I must say, on the civil side. In fact, this shrinkage has affected the entire space and aerospace program. There has been a recognition that one of the ways we can accomplish our goals is to readdress interdependency in a more proactive way. So, instead of the STIG being an organization that gets together to encourage things happening and to passively track what's been happening, we're saying we want to enter a mode where we cause things to happen and where we cause interdepencies to develop. You might say we're moving more *from* a bottoms-up, but not necessarily *to* a top-down, approach – because I think that would violate the concept of interdependency. But, we're certainly going to be more proactive.

We're saying we can't sit around and wait for things to happen, that we need to join forces and to look at our plans in a strategic sense, and that we need to share the workload and be sure there are, just as we've said before, no nonproductive overlaps and voids. But, this time we have to do it with more vigor.

What's been identified as being at the heart of this is the need to commit the agencies involved to the idea – all of the agencies involved; that is, NASA and DOD, as well as ARPA and DOE. It's everybody who has a common interest in space getting our heads together and laying out our plans in some sort of an integrated manner to show how we're essentially accomplishing our goals. This doesn't mean we're pressing for joint planning. I think it's very important to understand the distinction between joint planning and joint programs. We're not talking about the kinds of joint programs that are a necessary result of this interdependency effort; but we are talking about doing our planning in concert with each other and understanding where we're going and how we can get the biggest bang for the buck, as the expression goes.

We've now reached the point where people like Greg Reck and his counterparts in the Air Force, the Navy, and the other Services are saying we'd better do it. It's a matter of survival. There's a step beyond that, too. We'd better do it before somebody steps in and does it for us or, worse than that, *to* us. Because it *is* going to happen. Rest assured that there *is* going to be pressure, and there *are* going to be people asking whether the taxpayers' money is being used effectively.

I think both carrot and stick are involved in this whole exercise. It's my intent in capturing you, as I'm doing now, to make sure you understand that this is the single most important thing that could be going on in any STIG or STIG technical subcommittee meeting that's being held, and that it not only deserves but demands the highest priority attention of anything you're doing.

That's pretty much the end of my commercial. I'll just say a couple of words about format. We sent out to the technical committee chairmen an example of what we consider to be a good model, which is still undergoing improvements, of the road map we're requesting from you. This road map, which I'm calling to you attention, was produced by the power committee. We don't want to straitjacket you. You don't have to go the way of the power committee, but the power committee road map certainly represents the elements of what should be contained in whatever road maps you generate.

I'll tell you one other thing. And that is: There's been a great deal of concern with the problem of road mapping in a shrinking budget, an unstable environment. We get a lot of people who rightfully ask, "How can anybody generate road maps or make plans when the ground is shaking from under us the way it is in the current environment?" The answer is, "We have to. If we can't generate plans which show what we want to do, where we want to go, and what we would do with the money if we had it, then the result is there will be no money. It's that simple."

So with that, I'll take any questions or comments you may want to throw at me.

After Mr. Sadin concluded his remarks, the following questions were addressed to him:

Dr. Kumar Krishen (JSC): How flexible are we with schedule?

Mr. Sadin: I'll tell you something. If you don't deliver on the schedule I sent out to you, you're in big trouble.

Dr. Mary Connors (Ames): I have two questions. The first one is, what level are we talking about here? We have a couple of things we can readily identify as major programs, and those seem to fit in better with what you're talking about. But, we have a lot of little things running around, too. I'm wondering, do you want to capture them all?

Mr. Sadin: Let me answer you as best I can. I think that, as with any exercise of this type, what you submit ought to be backed by a level of detail at least one layer deeper than what you submit. I would suggest you have more detail than you give; that is, that it actually be a part of a road map step but that it not necessarily be submitted because it's going to go beyond what's needed by the people who are going to be looking at it. However, I would be prepared to answer any questions that are asked and to expect questions that will go back one level deeper. You will need to be prepared to either explain or, in some cases, defend what's at the higher level. Does that answer your question?

Dr. Connors: I think I was asking something a little different. What I was trying to get at is that we have a number of small, almost casual, and not well developed interactions. I was wondering if we wanted to capture those, too, although they're harder to put in road maps. Or, do we just want things that are a little better established? Let me also ask my second question. What are you going to do with these road maps once we've submitted them? When I try to get this information, people are hiding under their desks. This is not an activity people really jump up to help you with.

Mr. Sadin: I'm well aware of that, believe me.

Dr. Connors: So, I'm just wondering: Can we tell them what will be done with these?

Mr. Sadin: There are two uses that are going to be made of this material. One is that it's going to undergo intensive review by the executive committee of the STIG. There may be some major decisions made on the basis of what's seen, in terms of understanding between the agencies of Government, as to who's going to be doing what and who will go after which portion of the budget and what things may be cut out. The other thing that these road maps will be used for is to respond to inquiries that have already been started, and that will continue to be addressed to us in much greater detail, from sources outside the agencies. These outside sources are the U.S. Congress, the OMB, the OSTB, you name it. I think it's just the beginning of a process.

As for the people you're talking about getting help from; I understand nobody wants to be pinned down on this stuff. But, it may be just a matter of conveying to them what I said in my opening comments: If we don't have some sort of justification and some sort of demonstration that we're doing some kind of adequate planning, there's going to be *no* budget or there will be an increasing rate of *decay* of budget. I don't know how else to get people to understand that, and I hate for it all to be stick. I think there's also carrot. I think there *are* opportunities between agencies to do more with less, which is what we're all going to have to learn to live with. Does that answer your question?

Dr. Connors: I'm just looking for some rationale to get people behind the exercise. I think if there was some value added at Headquarters, that might help us at the Centers in marshaling this information.

Mr. Sadin: As I said, I think it's the carrot and the stick. There's going to be value added and value reduced. People may find themselves losing programs if their programs aren't justified.

Mel Montemerlo (NASA Headquarters): I think it would help us all if we knew the level these road maps are to be written to. For example, if you're talking to a group of technologists you might talk about the use of acyclic directed graphs. But, if you're talking to associate administrators or higher level administrators you would be speaking to a different plane altogether. So, it would be good for us to know whom these road maps are aimed at. My guess is they're aimed at affecting the associate administrator and other people at that level. Am I correct?

Mr. Sadin: I think you'd better step down a notch. Greg Reck is going to be looking at your road maps in fairly good detail first. I also think Reck is going to expect that his directors and managers will have assured him that they, too, have looked at the road maps in great detail and are satisfied with them. Reck has made that point many, many times. The Associate Administrator of NASA (I can't speak for the other Services) is going to turn to his directors and managers to find out whether they're satisfied with what's in those charts. So, what I'm saying here is: I think the road maps had better be at a level at which their language can be understood.

Mr. Montemerlo: I think we can put it together in a way that has a level that will be understandable by Greg Reck and people at that level; that is, an area that isn't their field. I think that if we come up with something which at one level is not exciting to them, it's not going to have the effect needed.

Mr. Sadin: I agree. That's why I said that I think you will want to have it backed up at another level of depth. Sometimes you can be surprised with the kinds of questions a guy like Greg Reck or Alan Schell or somebody else on the executive committee may ask. You may have to scurry to pull something out of your backup with them.

Mr. Montemerlo: You're looking for a draft that people at a medium level will appreciate, understand, and make some decision as to whether this is the way to go.

Mr. Sadin: Absolutely. I just can't help believing, and this goes back to the previous question, that if you don't do that it's not going to end up being a useful product. You just have to know that it's going to have to be a useful product.

Jerry Elliott: I'm going to ask a couple of questions. First of all, we've talked about road maps. I'm not sure everybody understands a clear-cut definition of road maps. In the past road maps, I think, were defined as only those projects that were interdependent and not all encompassing. But, it looks as if the definition of road maps has grown to potentially include all projects among the agencies and the military.

Mr. Sadin: That's correct.

Mr. Elliott: Could you please give us a clear-cut, single definition so we'll all understand what road maps are?

Mr. Sadin: I think you just gave it. Road maps have grown to potentially include all projects among the agencies and the military. You'll be able to see what's being done in the road maps you'll receive. I've just mailed out the complete set of road maps that came from all the different committees in the last exchange, and they vary in quality. I will reiterate that the power committee's was the best example. And, you can see that what's laid out in the power road map is a kind of national program. So, in a sense these *are* national technology road maps.

Mr. Elliott: So, you're asking that we deliver a road map not just for every interdependent program, but for every program.

Mr. Sadin: Yes. You know the schedule. Air Force Col. Dionne has asked if we can deliver *before* March 15th, which I gave as the drop-dead date for receiving the road maps for the video conference scheduled on the 21st. I can tell you that he's curious about reviewing them and has asked that, if there's any way to get them in sooner than the 15th, he'll be waiting for them.

Mr. Elliott: Mary Connors still is a little concerned about your answer to her question on the level of detail needed from some of these projects. Could you answer with some different set of words about this? There are some very, very small funded projects that we consider that we have some mutual involvement with; but should those be written up?

Mr. Sadin: I would think not. I think the question you asked really puts that in the proper context. You asked whether these are just road maps to show interdependency or whether they are road maps, as I described them, to depict a comprehensive national effort and to show where the linkages are. If the latter is true, we don't want to enter a level of detail that's irrelevant to demonstrate a small area of interdependency.

Dr. Peter Friedland (JPL): I have just one question to make sure I understand. It sounds like what we're looking for here is not a road map of projects, but a road map of technologies and applications that are being driven towards jointly.

Mr. Sadin: We also want to show both the discipline effort and the project goals, and how the projects are feeding into the accomplishment of national goals.

Mr. Montemerlo: That brings up a problem I think we know the answer to, because it came up in the telecon the other day with Marshall. There are places in NASA, and in the Air Force, where we don't know what the next number of projects are. What is NASA's plan for access to space?

Mr. Sadin: What we had was a little bit of the rebellion that we get every time at the telecon. You're not the first one to see people hide under the table. I don't worry about the people who hide under the table; it's the ones who come after me with a bat in hand that bother me more. And, you ask, "How in the world can I lay out a program when everything is so gelatinous and every day you call me in to take another hack at my budget? We don't know what the program is, and we really have a national crisis on our hands – at least in terms of how a lot of people here at NASA, and I'm sure the Air Force, view it –

and we have a lot of ill-defined programs." The only answer to that is to lay out a program that we think is right, to enter into it a little bit of imaginative thinking on the program we've chosen, and then to use this as an opportunity to show that there is zero or inadequate funding to accomplish our goal, to show that there may be a break in the line, and to say that this is not going to happen. And, that becomes an opportunity to make a case. It may not accomplish anything, but it's an opportunity to point out that people talk glibly about national goals but that there *are* programs – be they mission programs or research programs – to bring you to the goals.

Mr. Montemerlo: The bottom line is we have to come up with a road map that takes into consideration the fact that we don't know what a lot of the future projects are over the next few years. We need to put together a program that would make available at the appropriate time the technology to allow intelligent decisions to be made whenever they are made.

Mr. Sadin: Right.

Dr. Friedland: That brings up the question of grain size. This is a group made up of five subcommittees. Are you looking for *a* road map for operations, which is the overall goal of this group, or individual road maps for the five different disciplines that make up operations?

Mr. Sadin: I know it's not the former, because you go under the title of operations committee but you really are not a unified set. Even in propulsion you're broken up into different categories; and in operations I think it's worse. I would think it would be up to the number of your five subcommittees. But, if the story can be told with four, that's fine, too. Or, if it takes six . . . I don't think it's related to the number of subcommittees. I certainly don't think you're going to summarize it. We're dealing with something that can be strategically mapped. I think if you try to put a strategic map together for something called operations, I suspect you'll have trouble. But, maybe you'll have a simple overview that might show the relationship.

Dr. Friedland: A final question. I know it's in the examples, but what's your feeling about how far out anything makes sense for the purpose of this exercise?

Mr. Sadin: How far out did power go? Five years to a decade is about the only range I think can be of any use. You certainly don't want to go much farther out than that. It's a strategic plan; and a 5- to 10-year time frame is about right.

Dr. Friedland: I guess the only thing it's going to be hard to collect is, it's probably reasonably sensible to put together NASA and Air Force ideas. There are also people here from some of the other Services. But, there are whole other chunks of Government – the NSF and other agencies – who aren't represented. Is that okay? Do you want us to try to do some further research?

Mr. Sadin: If you feel there are other program elements missing, I think you ought to quickly get hold of those people and invite them to participate. Some of them are already members of the committee. What we've tried to do is to keep the committees populated with agencies that have laboratories. It could be some of the work is not being done in laboratories but is being done for the agencies by contractors. We have that with ARPA, for example. I don't know what to tell you, but I think you should feel free to invite whatever agencies or organizations you think are necessary to do the proper strategic job. And, invite them to become members of your committee or subcommittee if they aren't already.

Dr. Krishen: I think we can proceed with what you've told us. Thank you very much.

The meeting then continued according to the agenda.

Dr. Richard Miller (Acting Director Plans, Armstrong Lab, Brooks Air Force Base, San Antonio) is the Air Force Cochair for the SOC. He made some introductory remarks before he said:

Stan Sadin mentioned the budgets are shrinking. Indeed, that's true. In the DOD, we're not entirely clear what our budget will look like in future. Certainly, the manpower is going to shrink at a rate of about 4% a year – as near as we can tell – for at least the next 5 years, which poses problems for us. It *does* pose the need for more cooperation, more interdependency, to make sure we're not overlapping in whatever we do. The Services are doing that more and more under what we call Project Reliance, which has fostered the movement of whole groups of people from one Service to bed down with another Service doing similar kinds of work. This has helped us protect our budgets to the extent we have been able to do that.

In terms of the preparation of road maps: On the surface of it, producing a road map won't be a problem for the Air Force side of the house. We do road mapping every year in our technology area plans. I can extract in a day's time the work the Armstrong Lab is doing that's oriented towards space activities that fit in here. What bothers me greatly is: When you don't know where you're going, any road will take you there; and there's going to be this continuing need for information. I don't think the initial part of it is going to be a big problem from the Air Force side. I don't know if we'll be required to go into the Department of Energy, the Department of Transportation, or some of these other agencies that also have parts and pieces of programs that, although they may not be stated as being directly applicable towards space, could be construed as being applicable towards space. So, that may be a problem.

Dr. Krishen introduced Jerry Elliott, Dick Rogers (who was at the Cape), and Lana Arnold. Answering Dr. Miller's concern, Dr. Krishen stated that NASA-wide there would be no problem finding enthusiastic people to work with the SOC. He said the issue is how we will get counterparts from the Air Force and how well we can manage to get that activity under control. Dr. Krishen remarked that the basic material for strategic planning is knowing what's happening.

The following presentations were designed to help the committee identify areas where they can make road maps easily. Dr. Krishen ended his remarks by suggesting that tomorrow the subcommittees would focus on designing road maps.

The presentations are summarized below.

The subject of Dr. Charles Weisbin's (JPL) presentation was New Robotic Activities at JPL.

Dr. Weisbin spoke about three projects that are now under way at JPL: (1) A hazardous materials incidence response robot (HAZBOT). The objective of HAZBOT is to work with the JPL fire department in case of emergencies. Dr. Weisbin showed a videotape on the project. This project, one of a series of "quick wins" started 3 years, will become part of the JPL fire department operational tool kit this month. HAZBOT grew out of a Remote Tech vehicle purchased by JPL and subsequently upgraded. All of the drawings of the new manipulator and the new control station have gone back to Remote Tech, so industry is benefiting from JPL's development of HAZBOT. Remote Tech is selling the control system designed by JPL as part of their upgraded system. KSC and JSC have expressed an interest in getting a HAZBOT; ARPA is also interested in HAZBOT for demining. As Dr. Weisbin said, "If we have to make up a national program plan that focuses on dealing with hazardous materials in terms of a joint agency, this is one that might be possible." (2) Microrovers. These are rovers for solar exploration that are shrunk to a size that's smaller and, therefore, less expensive to launch. There's actually a flight project under way called MESUR Pathfinder. (Dr. Weisbin then showed a videotape on the Mars Environmental Survey (MESUR) Pathfinder project.) The onboard image processing of the MESUR Pathfinder is also being supported by ARPA in their Unmanned Ground Vehicle Program. The MESUR microrovers might also be able to go on the battlefield to perform sentry duty. (3) Multisensor robotic inspection of space platforms, which involves both ground control and automated inspection technology. This project has aroused interest in general inspection cases; i.e., inspecting airplane wings for flaw damage.

Dr. Weisbin then discussed new projects JPL is just starting on which no work has been done. These projects are: (1) DST (Distributed Space Telerobotics), which is a collaborative program with ETL and MITI (the Japanese). Specific Japanese interest in joint robotics research is on optimal camera viewing. It has taken 4 years to negotiate the DST project into which the Japanese and NASA are investing money and are defining a common project. (2) Teleoperated microsurgery and its commercialization. MicroDexterity Systems, Inc., which invested $4M, and JPL got together on this. Dr. Weisbin stressed that, for teleoperated microsurgery, precision control is vital. (3) Ground operator environment. The goal of this project is to design, develop, and deliver a ground operations telerobotic work station that can work jointly with JSC and, ultimately, be supported at JPL and throughout several of the NASA laboratories involved in space station work.

Dr. Weisbin ended with a list of technical goals he thought would be interesting to look at in the future. Dr. Weisbin pointed out that, in terms of interagency collaboration, there's clearly an interest and a correlation between the unmanned ground vehicle program and the JPL rover program, largely through real-time vision. There's also a connection to logistics in the San Antonio depots, largely through architectures; and there's a connection to small robots through sentries in the field doing surveillance. At best these programs are loosely coordinated, but they certainly leverage each other. But, in terms of having a common vision of what the target is long term, Dr. Weisbin doesn't think we're there yet.

Col. Gerald Krueger, the Commander of the U.S. Army Institute of Environmental Medicine at Natick, Massachusetts, talked about the capabilities of his laboratory and, in particular, where these capabilities may relate to the STIG and the SOC and to space applications and research in general.

The Institute's historical claim to fame is studying the effects of high heat, severe cold, and extremely high altitude (6,000 ft to 18,000 ft) as it relates to soldiers. They do a lot of work in nutrition and hydration and in the whole body perspective of training, fitness, and health. The U.S. Army Institute of Environmental Medicine is a subordinate laboratory of the Medical Research and Development Command headquartered at Fort Detrick in Frederick, Maryland. An Institute goal is to prevent injury to the body; they come up with strategies to achieve that goal – many are materiel or pharmacological and non-materiel or procedural in form. Emphasis is on early intervention.

Col. Krueger discussed a number of ongoing activities at the Institute. Among these is a joint biomechanical laboratory, established with the Navy and with the Natick Army developer, to look at load carriage. Col. Krueger stressed that, "with modern hygiene, modern attention to preventive medicine, and modern education of our soldiers, diseases are no longer the number one cause of lost duty days." The number one cause of lost duty days now is "injuries to the arms and legs. Most of them come from sports activities." They also study mood and motivation of people deployed to harsh climates, as well as jet lag countermeasures and hydration and nutritional requirements.

Circadian rhythms were highlighted by Col. Krueger. We have two lull periods in a 24-hour period that affect performance: the first is between 2:00 and 6:00 in the morning, and the second is in the early afternoon. There is a measurable performance decline, about 10% to 15% in cognitive performance, at those times. In a sleep-deprived individual, performance decline can reach 35% to 40% – an important consideration in the design of any work-rest schedule. Melatonin, a naturally occurring hormone in the body, can act as a sedative; but melatonin dissipates when it's exposed to light. Further study into this might mean we could regulate the work-rest schedule and increase performance effectiveness.

Col. Krueger then spoke about the last SOAR conference and specifically about two papers that were presented by employees of the Institute. (These papers are included in the SOAR '93 proceedings.) The environmental monitoring technique developed at the Institute has been put into a PC-based model for medical doctors working with casualty prediction in a preventive medicine way. The German military and the Canadian military have either worked with predicted models from the Institute or have adopted procedures developed by the Institute. Col. Krueger stresses that, because predicted models have held up time and time again, the modeling aspects help us to anticipate what to expect and to decrease the amount of testing we have to have.

As for interdependencies, Col. Krueger mentioned that Natick Laboratories have been involved in food preparation for NASA and the astronauts since the early 1960s. There is a mission going up in the spring that will carry irradiated steak provided by the Natick Army Engineering Center. MREs

(Army meals ready to eat) were used in Desert Shield/Desert Storm, in Somalia, and in Bosnia to feed civilians. Because of requests, brand name items (Chiclets, Tobasco, etc.) are now appearing in the MREs; and a number of new, innovative food technologies are available in the market today that have come about as a result of our need to service astronauts in space and soldiers in the field.

Ms. Karen Thompson (KSC) made a presentation on KSC's Advanced Technology Office.

Ms. Thompson is with the Technology Transfer Group, which has recently undergone reorganization. Her group works with the Center Directorate, Administrative Activities and Base Operations, Biomedical Operations, and various directorates – Shuttle Operations, Payload Operations, and Safety, Reliability, and Quality Assurance. Ms. Thompson's directorate is Engineering Development (also known as Design Engineering). The new name for her office is the Technology Development and Transfer Office. KSC has many development labs, and many KSC technologists are assigned to the Engineering Development Directorate.

Emphasis is on commercialization of technologies, according to Ms. Thompson. The chief of her group is also the patent counsel of NASA; KSC is the only center where this is the case. "It has come in very handy for many of the partnerships we've been putting together, to have a patent counsel right on our team." The Technology Transfer Group is made up of Technology Assessment, Dual-Use Programs (which Ms. Thompson manages), In-Reach Activities, where they go into all the directorates to find technologies that look good for commercialization, Dual-Use Program Support, Technology Counselor, SBIR Program Analyst, and Tech Transfer Specialist. Also, the group has a Technology Integration Team with program control and marketing and communications, and they have a budget analyst from another directorate who sits in the office and handles all of the budgetary matters relating to the group. The Technology Development Team was the focus of Ms. Thompson's presentation.

Selected portions of Ms. Thompson's presentation are given more fully below:

The office has been arranged in disciplines, although there are no strict walls. It's been done more for convenience, to try to find technology discipline managers who have the kind of background that will aid them in overseeing projects to make sure they're getting the kind of results that are wanted. In those disciplines are included nondestructive evaluation, environmental and life sciences, electrical and electronics, advanced software and robotics (two different people are involved in robotics, which shows the walls are not really strict there), fluids and materials, atmospheric science, and human factors.

In answer to a question from the floor, Ms. Thompson explained that all the technology discipline managers are being told they are to look within their disciplines for commercialization opportunities. They have not worked with the technology transfer people before, so there's a liaison between the two groups who is trying to coordinate all of the activities so the two groups will mesh better. But, Ms. Thompson stresses, that's an interim position; it's not going to stay there.

Some of the current work is as follows: (1) in Advanced Software, development of advisory and expert systems for health monitoring, diagnosis, prognosis, and problem resolution for Shuttle and ground systems; software architectures for integrating and distributing both conventional and intelligent systems; scheduling systems to assist in optimization of vehicle processing activities, which has worked into a great commercialization effort and is of interest to a major airline; and multimedia and conventional content database management systems; (2) in Robotics, work on various tasks involving Shuttle, payload, and facility maintenance tasks, particularly hazardous or tedious tasks; and Shuttle and payload inspection tasks, particularly enabling inspection of heretofore unobservable areas in automated interfaces to analyze databases; (3) in Materials Science, quite a bit is done in the area of improving methods for construction, maintenance, and repair of ground processing facilities; new generation protective gear for hazardous materials handling; and improvement of methods for quantitative analysis of Shuttle debris samples; (4) in Electronics and Instrumentation, a number of good commercialization projects; advances in sensor and transducer technology as well as data acquisition and transmission systems (a number of companies are competing to work with KSC on one of these); and improvement in equipment and techniques used for testing environment and ground support systems during processing; (5) in Nondestructive Evaluation, imaging systems for electronic mold impressions and detection of subsurface flaws; application of technologies such as computer tomography to assist in logistics maintenance areas of the Shuttle; and reliability and accuracy improvement for critical bolt tensioning;

(6) in Fluids, developing smart fluid system components to monitor health and failure trends; and improvement of leak detection methods including hydrogen leak sensors; (7) in Human Factors Engineering, applying industrial engineering techniques for operations analysis to determine areas where the cost of ground processing operations can be reduced; and test applications of state-of-the-art developments into identified engineering areas; and (8) in Atmospheric Science, weather detection because launch scrubs cost NASA a lot of money for every day that launch is delayed (many commercial weather services are very interested in this technology).

Ms. Thompson then discussed what they try to incorporate as they're going through projects.

The user (the operations engineer) is involved from start to finish. Operations engineers have very good ideas and want to give their input on projects. They want to make sure they're "not coming up with a gold-plated widget that no one wants to use." So, Ms. Thompson's group tries to leverage work that has already been done, or is being done, at other Centers. In some cases, they've set up formal collaborations. They look at success metrics and quantitative measures of benefits to make sure that what they're doing is really cost effective and worth spending the research money on. They also do project implementation plans for the customer. In operations areas where the technology is to be used, they make sure the operations management will sign on and say "Yes, I will spend part of my budget to implement this once it's developed." And, they're looking more and more at the commercial technology transfer.

In commercial technology transfer, they've started to develop partnerships that offer shared funds. They're trying to move back development earlier and earlier to save NASA dollars and to make technology available for the rest of the country. Some of the funding sources are as follows: Code C and Code DD, Minority University Programs (these are used for research tasks; the escape suit is a recent example), engineering technical based funds through Code N, the Center Director Discretionary Fund, Small Business Innovation Research (SBIR) programs, and Shuttle Program money. Center Director Discretionary funding and SBIR funds are used for projects that have promise but that may take a bit of time. After proof of concept, they started bringing in Advanced Concepts, Minority University, and Advanced Development. Operations, any of which may start kicking in money to implement the project. SBIR or Center Director Discretionary funding is used only in the very late stages, such as for SBIR Phase III or commercialization type projects.

What do projects have to go through before they get funding?

Ms. Thompson said her group starts collecting concepts and proposals from KSC, other agencies, and industry, too, and they go to the various directorates. They go out to their managers, and the managers rank the projects; they then go to a technology discipline team composed of engineers and scientists who have background in a specific discipline. There is a team for every discipline. The materials team, for example, is made up of chemical engineers, metallurgists, polymer chemists, etc. From the technology discipline team it goes to a technology management team largely composed of division chiefs throughout KSC. Finally, it goes to the Center Director's Review Council and from there into special reporting formats, which allows them to go out and look for funding from the various funding sources.

Some of the partnerships at KSC are with: (1) design engineering laboratories that have contractors involved; (2) directorate program offices; (3) contractors (McDonnell Douglas, Lockheed, Rockwell, and I-NET); (4) Ames and Langley (formal MOUs), and other NASA Centers; (5) universities; (6) in the dual-use area, with the State of Florida Technological Research and Development Authority (they've come up with matching funds to go with NASA funds); and (7) other Government agencies, notably DOE's Los Alamos National Laboratory for electrically conducting polymer coatings.

As far as outreach activities are concerned, Ms. Thompson's group also interface with other NASA Centers and with NASA Headquarters for joint ventures and work with other Federal agencies on many of their projects. Also, interface with universities and industry, and have several consortia started.

Some of the TRPs have been set up by a marketing person in their group. This marketing person has worked with ARPA and has done other interagency technology investment activities with the ATP and the NSF (National Science Foundation). A Florida TRP is under way that involves several companies, universities, and other agencies. There is also a Gulf Coast Alliance for Technology.

In answer to a question from the floor, Ms. Thompson said there is a person in her office, Priscilla Elfree, who is very involved in the Gulf Coast Alliance for Technology. "Ms. Elfree got all of these people together and was very instrumental in getting things started. She attends all of their meetings, coordinates, and brings information in, and look at ways that information can be given out to help the group."

On the interface with State agencies, Ms. Thompson said her group set up a formal partnership signed between the Governor of Florida and the KSC Center Director on dual-use programs. They are trying to get other States interested in similar partnerships, because they feel other States might be able to come up with funding to undertake similar projects. They put this partnership together to deploy commercially viable technologies to meet KSC's needs as well as to commercialize selected technologies. But, they don't work exclusively with Florida. When they have a dual-use program, they let the whole Nation know about it. Ms. Thompson said, "If we work with a Florida company, the industry partner has to provide a minimum of 25% of the total project cost, with the remainder split half and half between Florida and NASA." Also, the TRDA, which is the nonprofit organization Florida put together, may offer the same kind of plan for companies outside Florida that are willing to set up manufacturing facilities within Florida. As Ms. Thompson explained, the purpose for the Florida money being invested is Floridians want more jobs created in their State.

In answer to a question, Ms. Thompson admitted that, at the moment, NASA Headquarters is telling her group to do these programs but that they're not coming up with funding to do them. So, KSC is having to come up with funding within the Center. At present, Ms. Thompson's group has come up with small projects where NASA's portion is under $200K per project, which means almost a half million dollars are available for each project (because Florida contributes an additional $200K). In the future, they hope to attempt larger projects – if they can arrange for funding. Projects currently selected are ones that address issues that have to be solved by NASA.

Steps in the dual-use program are to: (1) select candidate technologies (NASA's need for the project is paramount); (2) identify and assess potential markets (KSC uses the Research Triangle Institute (RTI)); (3) prepare a Technology Opportunity Announcement used both by RTI and Florida (the same announcement is used to save cost; RTI produces the original announcement, then the State of Florida puts its own cover on it); (4) conduct industry briefings with all industry candidates (candidate profiles are done first; the Patent Counselor is there also); candidates can come up with a commercialization plan in the form approved by the Space Act Agreement – that is, as an unsolicited proposal through a university or nonprofit organization – or, if they want to use the Florida matching funding, they can submit through the Florida TRDA (the TRDA selects its own candidate and sends KSC an unsolicited proposal); and (5) make internal selection from commercialization plans.

KSC's partnership with Florida was signed in August 1993, and the first announcement went out in September. Their first project is a universal signal conditioning amplifier, which is a field installable or self warm remotely programmable amplifier that works with a random access memory attached to various types of transducers. Apparently, there's a need for this in industry. Ms. Thompson's group received a number of responses. Eight companies came to the technical briefing *after* the weeding-out process. Some large manufacturers outside of Florida have contacted Ms. Thompson and have shown an interest in this project, but as of yet no plans have been received,

On being asked whether any of the plans has gone to completion, Ms. Thompson answered, "I suspect the first one will be put together within the next week or two. You have to give companies long enough to put a commercialization plan together, so the first time we could send out an announcement was in September. All the deadlines are happening now." A university has to perform the administrative functions, Ms. Thompson added, so that a project can come into NASA as an unsolicited proposal.

On being asked, "What's the NASA funding going for?" Ms. Thompson replied, "Normally, the way this is set up is . . . our inventors and engineers will actually be participants on the project. So NASA funds will actually cover the manpower at KSC; the materials at KSC; all of the testing, which will be done at KSC; and all of the R&D functions, which are also done at KSC. But, the manufacturing portion will be done by the industry partner because our inventors have already come up with the prototype." In answer to another question from the floor, Ms. Thompson explained that normally funds don't physically change hands. The company pays for its portion as does Florida; and NASA pays for its portion. "This is something new, and it's evolving as we go," continued Ms. Thompson. "A lot of how a project's handled depends on how far along the technology is. Some of the first ones we selected were pretty far along into the development process, because that way they're less costly to go on and get to an end product. So, we're going to be going through changes as we go."

When Mr. Montemerlo remarked that a lot of interesting legal problems may arise out of these activities, Ms. Thompson admitted, "It's getting sticky." Ms. Thompson went on to say, "In our case, we don't want to come up with the final product. For one thing, our engineers don't know what's off the shelf in some areas. If they go to a manufacturer who's working in a very similar market, that manufacturer has already done the necessary market assessments. They know what they can get hold of. We are not in the business to know the cost efficient way of manufacturing 1000 units."

Ms. Thompson ended by commenting that KSC has done something new: KSC has acquired title to contractor-developed software and has obtained copyright protection for it, and has also licensed companies and software houses to make the software commercially available. Mr. Montemerlo remarked, "This is really a pathfinder activity for NASA. It's unusual for NASA to license software. Software is usually something that goes into the public domain."

Ron Dickerman (former Deputy Director and Director of the Army Space Technology Research Office; now part of the Space Applications Technology Program) opened his presentation by saying his office is one of the early casualties of budget downsizing and reorganization within the Army, and has become part of the Army Space and Strategic Defense Command.

The past paradigm for Army R&D was, if you were a laboratory you got money to go out and do great and wonderful things and try to work them into whatever applications your department was charged with. Now it's the reverse: As Mr. Dickerman said, "If you don't explain to these guys, maybe not the technology but the objective, they take the money and then make you come back and explain why they should give it back to you." Mr. Dickerman believes that answers the question why we should take part in preparing these road maps.

The Army has no mission in space. What the Army has is a mission to operate ground forces to support national objectives. The Army takes products developed for space systems and finds ways to use them on the ground. Mr. Dickerman has this advice for all developers: "Be aware that what you're doing affects the guy on the ground." Products being considered presently by the Army are being looked at to augment the capabilities they're losing because of the decrease in military personnel. According to Mr. Dickerman, "You can't lose that many people without a decrease in mission assignments and without some degradation of capability. We're hoping some of these products will make up for the lack of manpower."

Mr. Dickerman's office evaluates the technologies that will "support or enable capabilities that put products in the war fighters' hands." But, through Project Alliance and through the STIG, Mr. Dickerman hopes the Army's interest in technology will no longer be aimed specifically at the soldier but will also support the Air Force, the Navy, and the Marines. Some of the Army's capabilities are also used during civil emergencies (e.g., Hurricane Andrew, when GPS receivers were used to help the relief forces find their way around).

"We can't afford to take technology applications 5 or 10 years down the acquisition road to find out we've been barking up the wrong tree," Mr. Dickerman said, "and start over again." To prevent this, the Army Space Exploitation Demonstration Program has been developed "to take technologies, concepts, and off-the-shelf equipment, put those together in a demonstration or an application demonstration, and take it out to the guys who are actually going to be using those capabilities to have them tested. In that way, we know before we even start down the acquisition cycle that this thing is really going to be useful."

In answer to the question whether any of this would apply directly to making road maps for the four subcommittees meeting today, Mr. Dickerman answered, "Perhaps not specifically. The reason for showing these to you is, when you start looking at how these technologies are applied to the space platform, they have an impact on how that platform operates and performs. Which in turn has an impact on the product that then comes back to Earth. This is what we're using; this is how we're using them; this is where we're using them. So now, when we go through the subcommittees, an idea may be triggered that may be critical." Mr. Dickerman's presentation also is intended to demonstrate the filtering process his office goes through; he stresses that the final filter, of course, is how many dollars they will get.

Mr. Dickerman then discussed several technology projects that are under way with his office – one focuses on improved uses of the GPS receiver, two focus on exploiting weather data for applications, and the last one Mr. Dickerman covered focuses on the acusto-optical tunable filter, which will serve as the basis of a hyperspectral imaging capability. In answer to a question, Mr. Dickerman said that most of the programs are funded under program 63A, although some are 62 as opposed to 63A.

The final item of Thursday's agenda was addressed by Mr. Robert Savely (JSC) – a discussion of SOAR '94. Mr. Savely showed a vugraph sample schedule (a template) and handed out sample mailouts from last year's SOAR, which triggered discussion of when the next SOAR conference was to be held. Because of several challenges from the floor, Dr. Krishen explained why it is vital for SOAR to maintain its autonomy. Dr. Krishen said that a sizable amount of money is being spent by the Federal Government on these technologies.

To answer some of the debate occasioned by further remarks, Col. Krueger had two proposals: He first suggested that SOAR '94 could co-locate and hold its conference in Pasadena, California, either 2 days before or 2 days after the international conference already scheduled there. He also mentioned that one of the most harsh criticisms received at the SOC after the last two SOARs was that most of the JSC people did not attend the meeting at all, and those who did attend came in to hear a paper and ran back to their offices afterwards. "So, many of the travelers who do not work at JSC, who expected to spend time interacting with JSC people, didn't have that advantage," remarked Col. Krueger.

Dr. Krishen said that the idea all along was to rotate SOAR to different NASA Centers. The best thing that could happen to SOAR is that it should be held at different NASA Centers and at different Air Force bases. The question was asked, "Who do we want to come to SOAR?" It was recommended that "SOAR be modeled something like ISIRAS, in that it be aimed at getting a level of management involved that gets an overview of everything." Therefore, "Let's pick what the purpose is and what level of people we want there and maybe have it every other year." It was suggested that having a yearly theme might answer some of the criticisms. It was stressed that travel is really tough and that you have "to show value added to send someone to a meeting."

Dr. Miller ended the day's session by proposing that the conversation be carried on at dinner. As a final point, Col. Krueger suggested that we ask not "Why do we need SOAR?" but "What do we lose by not having SOAR?"

Friday's meeting began with Mr. Jerry Elliott's presentation on technology road maps.

Mr. Elliott handed out samples of the power committee's road map, which was recommended as a model by Mr. Sadin yesterday. He mentioned that a collection of interdependency sheets on each project had been put together previously, and that he had compiled a statistical analysis from what was collected.

"We in the STIG have a charter," Mr. Elliott stresses. "Road maps." Mr. Elliott then provided some chronological developments/milestones: (1) October 15, 1993, action for co-executive secretaries to provide the technical committees a sample road map for guidance; (2) October 29, 1993, action for power and propulsion committees to produce the road maps for their areas; (3) November 19, 1993, action for information, flight vehicles, structures, operations, and environment committees to produce road maps for respective areas; (4) September 1993, STIG general meeting with a discussion of technical road maps; (5) December 10, 1993, video conference that threw out sample road maps; (6) February 1, 1994, audio teleconference to address the issue with cochairs.

Mr. Elliott said three dates are very important: (1) March 1, 1994, telecon to conduct a progress review and address new issues; (2) March 15, 1994, road maps are to be faxed to the co-executive secretaries; (3) March 21, 1994, designated for the second video telecon. We should have completed our preliminary cut, as best we can, by March 15. Mr. Elliott feels the subcommittees should do something simple and focus on interdependent projects as their first goal.

He then proposed the subcommittee cochairs take the action in their own areas to produce the required road maps. To aid the cochairs, Mr. Elliott and Ms. Arnold put together four packages of data sheets on the interdependent projects, which could be used as a basis for the required road maps.

The concept of road maps has expanded, Mr. Elliott noted. With this in mind, Mr. Elliott provided these guidelines: There is no standard format, but a lot of emphasis has been placed on using the power committee format. Whatever format is chosen, some basic information is required: (1) descriptive name, (2) sponsoring organization, (3) time span and major milestones, (4) dollars invested by each sponsor each year, (5) relationships between individual efforts, (6) program goals and, if applicable, differences in goals of participating organizations. Also, (7) objective details in the technology area; (8) milestone details; and (9) description of approach to managing interdependent technology programs.

The following questions were raised: What is the goal of the road map? And, who wants the road maps? Dr. Krishen answered the second question by saying that, on the NASA side, Greg Reck wants the road maps. Mr. Reck wants these road maps because they will be presented to Mr. Goldin. When asked, "Has GAO asked for road maps?" Mr. Elliott answered, "They *have* asked for road maps in the Air Force area." In answer to the first question, Dr. Miller said that the objective is "that somebody very high in NASA can go back and say to Congress, 'Yes, we have coordinated our program with the other players on the national scene who are involved in space research, development, and operations.'"

It was noted that Code U has already developed road maps. Both Ames and JSC are completely rewriting proposals for any funding they want for FY95 and beyond. This will be presented to NASA Headquarters in April. By May 1, everything in life sciences will be "up to date and fresh in our minds." Dr. Miller suggested that it may be an option for the life sciences subcommittee to say they are awaiting finalization of the information that will be available in April, at which time they will prepare their road maps. To the question, "Does that include the Air Force portion of life sciences?" the answer was, "Any place that NASA has set up a program they are doing jointly with the Air Force would show up in it."

In an attempt to answer some of the questions raised, Dr. Krishen said, "One of the things we're trying to do here, with Jerry [Elliott's] help, is to do the formatting for you. Give us the basic inputs; we'll take care of the rest. It doesn't have to be complete. By March 15 if you are half done, give us what you have." It was suggested that a couple of people from NASA and a couple of people from the Air Force could sit together and look at the four or five big thrust areas within the various disciplines, list them, show a couple of high-level goals, list whatever mutual programs support these goals, and be finished with it. Mr. Elliott agreed that this is exactly what is wanted and what the subcommittees are being asked to provide. "The first pass through on the subcommittees," said Mr. Elliott, "is to take the information we have – and we can be through with that in an hour or two – and hand it in."

It was suggested that a couple of things are missing from the guidelines. It was agreed to identify: (1) the users (answering the questions "Who needs this?" and "Who's asking for it?"); and (2) the specific capability that's being developed. Mr. Montemerlo suggested asking, "What are a couple of benchmark areas? Where would we like to be in 3 or 4 years?" One benchmark could be NASA and another the Air Force. "We should look at it from the point of view of good technologists who are keeping our options open. We should tie as much as we can to specific projects and places. For instance, in Code C areas," noted Mr. Montemerlo, "the road maps are going to be handled differently than in Code U areas."

Mr. Elliott summarized what's needed for a road map as follows: "The important thing is to decide what we want on it and the best flavor of what they're asking for, and that's all we can hope to do."

Mr. Montemerlo offered the following: "I'd recommend that folks get into the actual road maps. There are a lot of technology road maps that have been done. The AIA did an interesting set of technology road maps; other groups have done technology road maps. They're kind of neat. If you look at a technology road map, you don't need to say who the specific companies are or which agencies ask for specific things and who's spending $160K to develop this to get to that. It's not supposed to be at that level. We should ask, 'What are the important thrusts? What are the three to five important areas within that?'

"And then, for each of those areas we should ask, 'What are a couple of benchmark areas? What from 4 or 2 years ago was an interesting benchmark? This year, what's an interesting benchmark? Where are we? Where would we like to be in 3 or 4 years?' So, for each thrust if you had three benchmarks, the road maps don't have to be specifically matched to specific projects. Because in NASA, we can't match them. I still don't know what space station will look like. We don't know what we're going to use for the next replacement for Shuttle. We don't have those things.

"So we can't say that we're developing technologies for specific projects. I think the road maps ought to be looked at from the point of view of technologists – of managers of technology development who are keeping options open. I would tie it as much as you can to specific projects and places, but other than that, don't worry about it.

"Who's going to read this? In Code C areas, the road maps are coming back to me. But, in areas such as life support, human factors, life sciences, where it's Code U, I don't know what the downside of it will be or how the road maps will be used there. I can say it's people at the level of Greg Reck using them.

"What's Greg going to get? Eight committees, each with four or five subcommittees; each subcommittee is going to do a road map; each road map is going to be from 2 to 5 pages long. I can't see Greg studying each of these. He'll want to get a feel of them. The Air Force counterparts also will want to get a feeling that someone has thought about where we were, where we are, and where we're going. They'll also want to know that it's competent thinking based on a couple of things that have happened recently, are happening now, and that we'd like to have happen in the future. That's the level to which things should be pointed. Trying to find specific tasks is not necessary."

When Mr. Montemerlo was told, "What I hear you saying is, don't put dollars on this," he agreed, "Not right now." He added, "We're going to coordinate these things. We'll finish our draft this afternoon, send it to the NASA and Air Force people interested in this area, and say, 'Please send us your input.' All of the input we get back we'll take, integrate, and put in something. If they don't send something, we can't input it. I wouldn't get to the point of putting in dollars when we don't know what the dollar amounts are. But, dollars should be put in where we *do* know them."

Regarding Mr. Sadin's comments of yesterday, Mr. Montemerlo observed, "Stan said he's unhappy with how well the road maps are working so far. Those he's seen, except for a few, aren't very good. So, he's made the division chiefs in Code C responsible for putting it all together."

Mr. Montemerlo continued, "I think for the AI area we'll probably have 3 pages at most. We'll have four thrust areas; each of the thrust areas will have two or three major lines on a timeline. One will be a few years ago, one will be about now, and one will be from 3 to 5 years out. I think we can get some dollar figures. It might not be complete. But, we'll assure Greg we've coordinated on this. I see this as the type of action where you can lose but you can't win. I would say the chances of Code C adding money to a project are pretty much nonexistent. Code C hasn't any money to add to this."

As for the Air Force side, Dr. Miller added, "Somebody contacted General Paul, who *did* sign out a letter to the laboratory commander saying, This exercise is going on. The Air Force needs to be a player. Please support this exercise."

The SOC broke out into subcommittees to work on individual technology road maps. The road maps developed by the various subcommittees are summarized below:

Robotics and Automation:

Approach: a strategic plan. Two areas of focus: (a) automated maintenance and servicing and (b) robotic exploration vehicles. Time span: 1994 to 1997. Milestones developed for each. This road map will be distributed to members of the committee; what is presented here will be massaged once and sent on to Jerry Elliott to be put in format. "We will show the committee members what we came up with and incorporate their comments. But as for asking the question, 'Is this right or not?' This is a thumbnail strategic plan for the technology area." The road map as written can show multiple agencies "and it can help to identify ways that those agencies' efforts are potentially tied together."

At this point, Dr. Miller reminded everyone that on 21 March Dr. Krishen and he will have to report on these road maps. "In order to fill in some verbs, I need a one-pager as to who these players are." Dr. Miller was assured that a formalized input will be sent out to which he will have access.

Mr. Montemerlo said, "The division chiefs are hoping the road maps will come in from here. It would be better if something came in that was jointly done and coordinated." Dr. Krishen promised that anything received for formatting will be sent to the subcommittees for approval. "It's a team effort, each one of the subcommittees saying, 'This is how we did.' If they have major problems with it, they have to tell us." Because time is short, Mr. Elliott recommended that road maps be faxed, not mailed.

Automation and Intelligence Systems:

Took a straightforward approach. Chose five or six functional areas: (a) planning and scheduling, (b) ICAT (intelligent computer-assisted training), (c) FDIR (fault diagnosis, isolation, and recovery), (d) large-scale information infrastructure, and (e) knowledge base software engineering. The sixth area is underlying technologies. Concerning the first five areas: Are there any major breakouts? Tied the answer to specific programs, which provided the road map. Plan to build a technology vs. application matrix.

Mr. Montemerlo explained how the Automation and Intelligence Systems road map was arrived at: "The model was to take the entire area and divide it into a number of subareas. For each area, we figured out how many thrusts are necessary. For each thrust, we then had a how it was/how it is/how it will be. We characterized each of those with a phrase or two plus an example of a project that's ongoing in the Air Force or NASA. It's not complete. As far as the NASA tasks go, it's probably about 5% complete. But, it is characteristic of the entire program as we know it." Mr. Montemerlo stressed, "This is a very neat thing for getting across, at a top level, a program – the whole area."

Human Factors:

Started from the sheets Mr. Elliott provided plus basic insight. Dealt with interdependencies; did not try to do anything about human factors as a whole; just where actively acting with other organizations. Came up with five areas to pursue and write up: (a) TAGMUS (team decision making under stress), which is an activity between Ames and the Navy; (b) MIDAS (man-machine integration design and analysis system, which is an activity between Ames and the Army; (c) human interface with artificial intelligence, which is an activity between JSC and DOE; (d) workload analysis of astronaut activity, which is an activity out of JSC with the Air Force at Brooks AFB; and (e) visual display models, which is an activity out of Ames with ARPA. Expect to write up at least four out of the five areas.

Life Sciences:

Dealt with interdependencies; that is, where individual investigators with common interests are not necessarily working together but are doing similar things. Broken down into seven areas: (a) decompression risks, (b) radiation, (c) toxicology, (d) gravitational stress, (e) thermal risk, (f) crew support, and (g) medical operations.

Mr. Elliott remarked that we will need some basic elements for each of these areas. It was stated that the next level would be listing actual projects, which could get quite extensive. Everything itemized came from the sheets, so "that will be a good project for Jerry to do – to go ahead and get the information he needs out of the sheets." In answer to Dr. Kumar's question, "Do we have the description there?" the answer was that the description is in the sheets that they were asked to complete. "We really don't have MOUs or joint projects in most areas." Dr. Kumar asked, "What about the food project?" This led to an agreement that a road map could be done in the Life Sciences area on food (which is under crew support).

Dr. Miller asked, "What are you folks planning to do about any representation of dollars?" Mr. Montemerlo said, "I don't think we could do a good job of being complete on dollars. Anything we put together will be bad because people will take it as being more precise than it actually is. Therefore, it is my recommendation that nobody uses numbers." Dr. Miller agreed, with the proviso that we not put anything in "at this point in time. But, we'll all eventually have to cross that bridge, at which time a letter will have to be produced authorizing this."

Dr. Miller recommended that, if a dollar amount is put in, "feed it to Jerry Elliott, Kumar Krishen, and me. We'll make sure that whatever we do will be done the same, so we don't turn in one road map with numbers and another without numbers." But, as Dr. Miller cautioned, "Before we put dollar amounts on this, we need to come up with a definition of what dollars we want, who wants the information, and what they are going to do with it." Mr. Montemerlo suggested that, when Mr. Sadin and Mr. Reck get this information, even lacking dollar amounts, "they're going to be thrilled because they haven't got that now except from power." "Refine it next year," was Mr. Montemerlo's later advice. Mr.

Montemerlo promised to talk to Mr. Sadin and Mr. Reck about the limitations of these road maps as they stand now.

Mr. Elliott reminded the committees that something has to be faxed to the secretary by March 15. He requested that all input be received by March 1.

As a result of the SOAR discussions yesterday, Col. Krueger said, "We're proposing to have the SOAR conference next February, 1 year from now, somewhere in the South. I would advocate that keeping a Government-centered, function-oriented conference separate and apart from an international meeting is probably an excellent idea. Other international or national groups tend to bring in a spillage of other players who derail your train."

A second proposal followed this: Rather than a general meeting with the listed categories, pick an area of special concern and concentrate on that instead of the "ya'll come" approach. A major theme workshop, solve a problem that perhaps everybody in that group agrees is a controversy, and don't just have a general meeting of all these areas.

Dr. Friedland suggested that one, or at most two, underlying workshop themes should be found. May not have advanced papers; a few position papers presented; but a workshop type of meeting. "Make there be incentive other than just giving a few random papers." Mr. Savely suggested that they might concentrate on manufacturing and information technology, for example, to attract the business community.

Dr. Krishen said that ideas for a theme could be discussed over the next several months. (Submit theme ideas to Dr. Krishen and Mr. Savely.) He agreed that, ultimately, industry must be involved in order to demonstrate the benefits of the taxpayers' investment in research.

Mr. Montemerlo suggested that a goal be set for the STIG working group. "The goal would be: Every year, let's coordinate better than we did last year. Let's not just have workshops for the sake of having workshops. We ought to turn this into a high-level coordination, which would make something useful for a target audience of mid to higher level managers to provide support for purposes of making some determination on their own programs and for telling Congress that real coordination has occurred."

It was said that the "real benefit is from other people getting overviews of what you're doing and you seeing overviews of what they're doing. Our best role is to provide interface at the mid level. Program managers need to know what has been done, not the degree or detail. We should consciously bring it up one level from where it has been to at least the program manager level." It's also "making interactions happen by identifying to the program manager things that could happen." Mr. Montemerlo agreed with that. He added, "The program managers ought to use this cross coordination among branch chiefs and branch-level researchers. What we ought to do is to use this to tell higher levels what it is we've done." It was stated, "I see the SOAR as the interaction and the SOC meetings as getting the information out."

Mr. Elliott said, "It sounds to me as if your STIG committee charter has changed. You need to reassess and reevaluate it. It should be a voluntary effort that leaves room for creativity and flexibility. If it's too formal, it will die; the creativity will be killed by the bureaucratic process. You should announce your charter in the current climate." Mr. Montemerlo amended this, "It's coordination we ought to do. I think the value added hasn't been here in the past as much as it needs to be. We need to figure out what value we can add and do it, and I think they'll love us for it. Number one, this group isn't going to die. No one is going to kill it; they couldn't. Not with the STIG. Something will continue to exist because it's been mandated. But, we can do something very useful. We should focus on ensuring that we can coordinate in the best ways. Let's come up with a database at an appropriate level."

Dr. Miller proposed that the decision as to when and where to have another SOAR conference be tabled. "We're working under a very tight schedule and a demanding assignment to prepare these road maps. There *will* be follow on to this first draft. We made a good start on this, and we'll have something to report on March 15 – and that's very important. We have at least begun in this area and have something to report. I'm also quite sure that there will be a comeback. In the meantime, I feel we need to go back and review the basic document: where STIG came from, who said it should exist, who signed up to it, and what we signed up to." After some discussion, Dr. Miller reiterated that the decision as to when and where to hold a SOAR be tabled. "We'll come out with an announcement of when another

Space Operations Committee will be. We would hope to have it sometime between September 1994 and February 1995."

Dr. Krishen stressed, "We would appreciate getting inputs – ideas as to what you'd like to achieve during the next meeting."

In closing, Col. Krueger, who will be retiring from the Army in June, had the following thoughts on how the STIG can continue to remain a useful forum:

"This group is the worker bee representative of your respective organizations. These organizations have some reason for being here and some credence for being here because it's somehow perceived as being useful to them. You should conduct the kind of business that Mel described. I would advocate that Richard Miller convene the next SOC meeting with specific goals in mind sooner rather than later, before the next fiscal year. Communicate at the worker bee level. Collaborative projects were created by Army people coming to the SOAR in August, so that feature is very nice. You ought to preserve that and jealousy guard it. Pay attention to the politics. Pay attention to the in vogue buzz words in Washington that are important. One that's important is the one that says, Are the DOD agencies and other Federal agencies collaborating, coordinating, cooperating, and sharing resources? They seem to give you a lot of limelight if you're perceived as doing this. The politically in vogue thing now is to prove that you are coordinating, cooperating, and sharing resources. It has nothing to do with science. Keep focused on the politics. Can you afford not to have a SOAR conference? If you've had one for 8 years in a row and suddenly you stop, it looks as if you've stopped coordinating. You don't know what the consequences of that might be. Pay attention. When you least expect it, the political system can zap you. Keep the communication lines open between Government agencies no matter what color suit they're wearing because it's helpful to do so, and you just never know when it may turn out to be something that blossoms forth in the organization in a way you can't perceive."

Dr. Krishen ended the meeting by saying that he personally is committed to this organization. He advised, "You never know what the benefits of a collaborative effort might be."

Section 4

Programmatic Review Presentations

STIG

STIG Operations Committee

Dr. Kumar Krishen / NASA

Dr. Richard Miller / AF

STIG

STIG OPERATIONS COMMITTEE (SOC) GOALS

- Produce coordinated technology roadmaps for each of the SOC disciplines
- Identify and characterize interdependent activities
- Encourage interdependent programs
- Interchange technical and programmatic information and share lessons learned
- Identify critical voids and non-productive overlaps in technology programs
- Promote technology transfer to industry and academic institutions

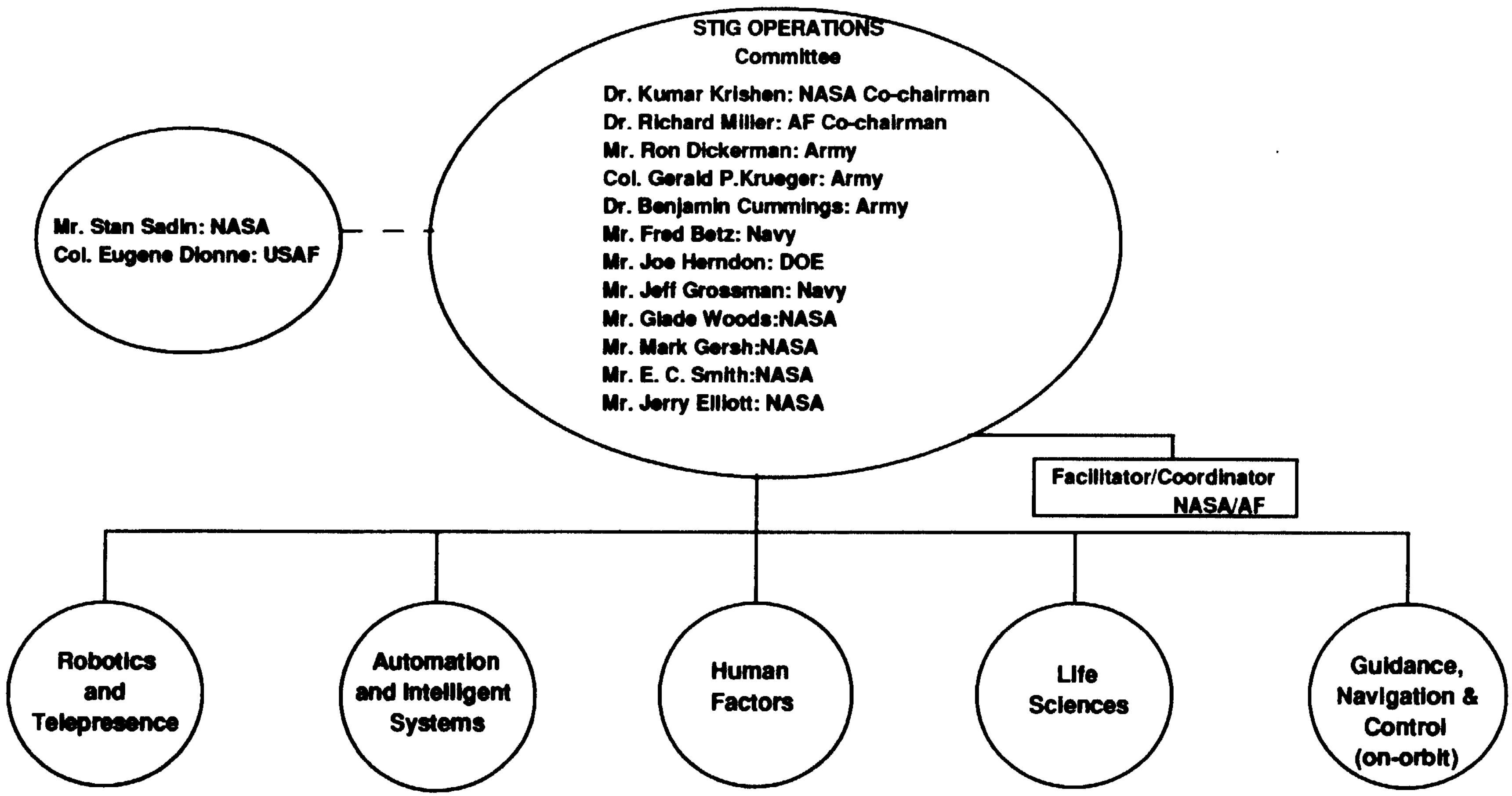
STIG

SOC Implementation Strategy

- Conduct STIG Operations, Applications and Research (SOAR) Symposium and Exhibition on a yearly basis
  - Include technical review of interdependent programs
  - Identify future interdependent programs
  - Identify areas of concern
  - Include Industry and Academia
- Organize Five (5) Subcommittees under SOC
  - Robotics and telepresence
  - Automation and Intelligent Systems
  - Human Factors
  - Life Sciences
  - Space Maintenance and Servicing (Effective 9/93 this sub-committee is being replaced with a new sub-committee named Guidance, Navigation & Control which will include on-orbit operations only)

STIG

SOC SUB-COMMITTEE STRUCTURE



ALL SUBCOMMITTEE MEMBERS ARE SOC MEMBERS

STIG

- Conduct two SOC meetings on a yearly basis
  - Review status and discuss progress on development of technology roadmaps within each of the sub-committees.
  - Review operations R & T plans, resources, progress within NASA, DOD, and DOE
  - Develop and maintain list and descriptions of interdependent programs
  - Encourage and recommend interdependent programs

- Facilitate communication of R & T results in operations area across agencies and various centers within these agencies involved in this R & T and also to industry and academic institutions
- Include both ground and space operations R & T in SOC activities
- Provide interface with NASA DOD, and DOE Operations Technology Thrusts and other STIG Committees, specifically, Information Collection, Processing and Transfer Committee

STIG

STIG Operations Committee (SOC)

Subcommittee Structure and Scope

STIG

- Robotics and Telepresence Subcommittee
  - Scope
    - Telepresence, teleoperation, telerobotics, autonomous robotics
    - Space maintenance and assembly, planetary exploration, terrestrial applications
    - Dexterous manipulation, navigation, perception and control
  - Membership
    - Capt. Paul Whalen*/AF Armstrong Lab
    - Dr. Charles Weisbin*/NASA JPL
    - Mr. Ed Alexander/AF CESA
    - Mr. William Helms/NASA KSC
    - Mr. Joe Herndon/DOE ORNL
    - Ms. Elaine Hinman-Sweeney/NASA MSFC
    - Mr. Mark Jaster/NASA GSFC
    - Capt. Ron Julian/AF Armstrong Lab
    - Mr. David Lavery/NASA HQS
    - Dr. Michael McGreevy/NASA ARC
    - Dr. Teresa McMullen/ONR
    - Mr. Jack Pennington/NASA LaRC
    - Mr. Charles Price/NASA JSC
    - Mr. Eric Rhodes/NASA KSC
    - Mr. Wayne Schober/NASA JPL
    - Mr. Charles Shoemaker/ARL
    - Capt. Gary E. Yale PL/VTA

* Co-Chairpersons

STIG

- Automation and Intelligent Systems Subcommittee
  - Scope
    - Knowledge-Based Systems/Expert Systems
    - Artificial Intelligence
    - Neural Networks
    - Fuzzy logic
    - Vehicle Health Monitoring
  - Membership
    - Capt. Jim Skinner*/AF Wright Lab
    - Dr. Peter Friedland*/NASA ARC
    - Capt. Mary Boom/AF Phillips Lab
    - Dr. Richard Doyle/NASA JPL
    - Mr. William Helms/NASA KSC
    - Ms. Kathleen Jurica/NASA JSC
    - Mr. Ralph Kissel/NASA MSFC
    - Dr. Melvin Montemerlo/NASA HQS
    - Mr. James Overholt/TACOM
    - Mr. Robert Savely/NASA JSC
    - Ms. Nancy Sliwa/NASA KSC
    - Dr. Abraham Waksman/AFOSR

* Co-Chairpersons

STIG

- Human Factors Subcommittee
  - Scope
    - Human Performance measurement, modelling and prediction
    - Extra-and Intra-vehicle operations
    - Human-Machine interactions
    - Training Systems
    - Workload and scheduling
    - Virtual Environments/Virtual Reality
    - Crew selection, composition, and coordination
  - Membership
    - Col. Gerald P. Krueger*/USA RIEM
    - Dr. Mary Connors*/NASA ARC
    - Dr. Kristin Bruno/NASA JPL
    - Dr. Carl Englund/NRaD
    - Lt. Col. Gerald Gleason/AF Armstrong Labs
    - Dr. Jonathon Gluckman/Navy Air Warfare Center
    - Mr. Joseph Hale/NASA MSFC
    - Dr. Jane Malin/NASA JSC
    - Dr. Richard Monty/ARL/HRED
    - Dr. Sylvia Sheppard/NASA GSFC
    - Dr. James Walrath/ARL/HRED
    - Mr. William B. Williams/NASA KSC
    - Ms. Barbara Woolford/NASA JSC

*Co- Chairpersons

STIG

- Life Sciences Subcommittee
  - Scope
    - Life Support
    - Health Systems
    - Biomedical research
    - Medical operations
    - Space Radiation Effects
  - Membership
    - Dr. Andrew Pilmanis*/AF Armstrong Lab
    - Dr. Gerald Taylor*/NASA JSC
    - Lt. Col. Roger U. Bisson/AF Armstrong Lab
    - Dr. Malcolm M. Cohen/NASA ARC
    - Dr. Jerry Homick/NASA JSC
    - Col. Gerald P. Krueger/USA RIEM
    - Dr. Gregory Nelson/ NASA JPL
    - Capt. Terrell Scoggins/AF Armstrong Lab
    - Dr. C. Lewis Snead/DOE BNL
    - Dr. Phil Whitley/Navy Air Warfare Center

* Co- Chairpersons

STIG

- Space Maintenance and Servicing
  - Scope
    - Maintenance and repair operations
    - Assembly operations
    - Servicing operations
    - Fault detection
    - Non Destructive Evaluation
  - Membership
    - (Vacant)*/DOD
    - Mr. Chuck Woolley*/NASA JSC
    - Mr. Jerry Borrer/NASA JSC
    - Mr. Tom Bryan/NASA MSFC
    - Mr. John Cox/USAF SSD
    - Mr. Bill Eggleston/NASA JSC
    - Mr. Jeffrey Hein/NASA JSC
    - Dr. Neville Marzwell/NASA JPL
    - Mr. Don Nelson/NASA JSC

NOTE: Effective 9/93, this sub-committee is to replaced by another sub-committee named Guidance, Navigation & Control and will include on-orbit operations only. Co-Chairpersons and sub-committee members are in the process of being formed

* Co-Chairpersons

STIG

SOAR '93

- Held at NASA JSC on August 3 -5, 1993 with NASA JSC being main sponsor
- 25 technical sessions in 5 disciplines
  - Robotics and Telepresence
  - Automation and Intelligent Systems
  - Human Factors
  - Life Support
  - Space Maintenance and Servicing
- 102 Technical papers presented - Proceedings under publication
- Plenary Session on "Operations Experiences"
- Panel discussion on "Operations Challenges"
- Keynote speakers
  - Dr. Melvin Montemerlo
  - Dr. Earl Good
  - Mr. Aaron Cohen
- 17 Exhibitors supported SOAR '93 symposium
- Over 300 registered SOAR '93 participants plus additional 200 for exhibition viewing

STIG

Concluding Remarks

- SOAR '94 - To be held Novemebr, 1994 in San Antonio, Texas and be hosted by U.S. Air Force.
- SOC First Meeting for 1994 is scheduled for February 3-4, 1994 at NASA JSC.
- SOC Second Meeting for 1994 is scheduled to immediately follow SOAR '94 Symposium November, 1994
- Annual report on status of interdependent programs is one key product of SOC and was developed prior to September 5, 1993
- Roadmaps of the various interdependent programs to be presented to the STIG Committee early 1994
- Participating agencies/centers very enthusiastic and supportive
  - many committee members nominated
  - want SOAR to continue
  - want periodic reviews of various R & T efforts

NEW ROBOTIC ACTIVITIES AT JPL

PRESENTATION FOR
SOC PROGRAMMATIC REVIEW MEETING
JOHNSON SPACE CENTER

FEBRUARY 3, 1994

JPL

C. R. WEISBIN,
TRIWG CO-CHAIR

E-Mail: Charles_R_Weisbin@jpl.nasa.gov

PROJECT

OBJECTIVE:

- Enable hazardous materials incident response teams to locate, identify, and potentially mitigate hazardous material spills/releases using a remote vehicle as opposed to Humans.

JUSTIFICATION:

- Remotely operated robots offer the opportunity to significantly reduce the risks to human life in the response to accidents involving hazardous materials.

BENEFITS:

- Reduction In Risk To Human Life/Injury
- Reduction In Incident Response Time
- Potential For Short Term Deliverables "Quick Wins"
- Application To Space Flight Operations Involving Hazardous Materials And/Or Operating Conditions

HAZBOT III EMERGENCY RESPONSE VEHICLE

- FILM
- 3.38 MINUTES

MICROROVERS ARE A MAJOR PROGRAM THRUST

- Develop autonomous behavior-controlled microrovers for science and sample acquisition on the Moon and Mars
- Conduct cutting-edge research in natural terrain navigation and behavior control
- Deliver microrover to MESUR Pathfinder flight project
- Supervise university research in control of small rovers by multiple control agencies

MESUR PATHFINDER MICROROVER FLIGHT EXPERIMENT

- FILM
- 7.28 MINUTES

PROGRAM MILESTONES

- PROGRESSIVE DEMONSTRATION OF IMPROVED VEHICLE RANGE AND SAMPLE HANDLING
  - » RELIABLE EXECUTION OF MULTIPLE 50-100m ROUGH TERRAIN EXCURSIONS WITHIN SIGHT OF LANDER('94)
  - » OVER-THE-HORIZON 100m TRAVERSE ('95)
  - » 1 km EXCURSION AND SAMPLE ACQUISITION ('96)
  - » REPEATED SAMPLE ACQUISITION AND RETURN TO LANDER IN 1 km EXCURSIONS ('97)

KEY TECHNOLOGICAL AREAS

- ON-BOARD VEHICLE PERCEPTION
- SAMPLE ACQUISITION
- ON-BOARD RESOURCE MANAGEMENT
- TASK ALLOCATION BETWEEN EARTH, ROVER AND LANDER
- ADAPTIVE SCIENCE ACQUISITION
- SPARSE MAPPING
- ERROR RECOVERY

TELEROBOTICS INSPECTION (JPL)

JUSTIFICATION

- Several studies have indicated that inspection will be an important activity for Space Station Freedom
  - NASA/JSC Final Report, Space Station Freedom External Maintenance Task Team, W.F. Fisher and C.R. Price., July 1990
  - SAIC Blue Panel Report, June 12, 1990
  - NASA Headquarters Report: Office of Space Station, Space Station Freedom Automation and Robotics: An Assessment of the Potential for Increased Productivity, December 1989
- Use of telerobotics can reduce astronaut EVA time
- Database from this task will provide actual experimental data for more realistic estimates for the SSF inspection tasks
- This task will also show technology readiness and identify what new technologies are required for inspection tasks

MULTISENSOR SURFACE INSPECTION

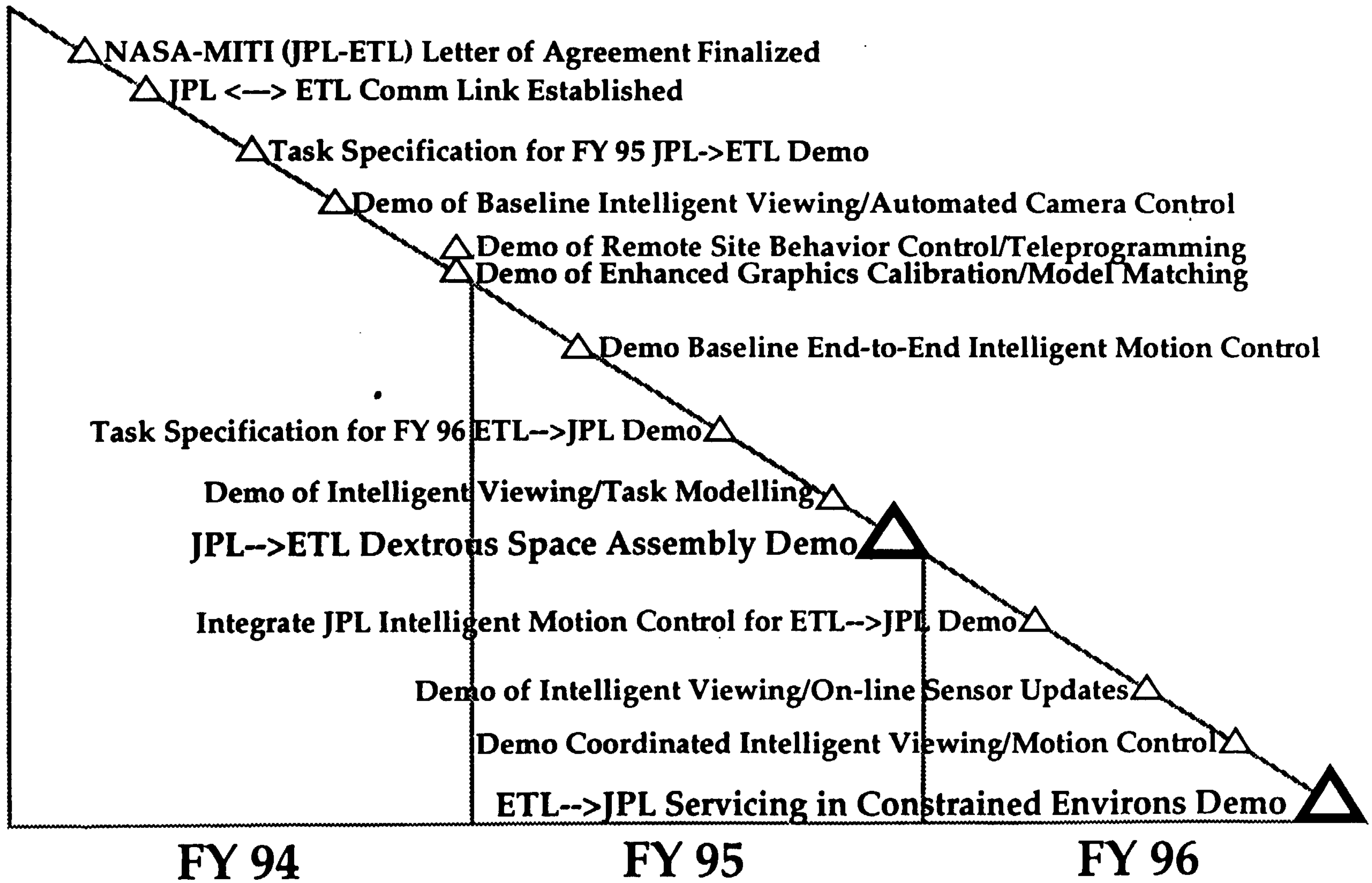
- FILM
- 5.35 MINUTES

Surface Inspection

- 1. Simulated solar lighting
- 2. Continuous motion inspection
- 3. Flaw detection to 3-5 mm
- 4. Automatic cataloguing of flaws in data base
- 5. Benchmarking detection capability
- 6. Dexterous 7-DOF manipulator motion
- 7. Stereo viewing and flyover capability
- 8. Multi-sensors: visual, pyrometer, gas, proximity, force, eddy current
- 9. Snake-like end effector

DISTRIBUTED SPACE TELEROBOTICS

Project Milestones



JPL

DST PROJECT HISTORY

- **NASA-MITI mutual expression of interest** in collaboration at i-SAIRAS (**11/90**, Kobe, JAPAN)
- Assessment of joint capabilities and emphases reinforced by NASA-JTEC reciprocal lab visits
- NASA Code RC solicited TRIWG Center concepts for a technical interchange/collaboration
- Interim visits of MITI/NASDA personnel to NASA Headquarters
- **JPL white paper concept** selected for further development **(12/90)**
- **NASA-JPL proposal prepared by P. Schenker and C. Weisbin** on NASA Hq request (**6/91**)
- Japanese technical counterparts identified by MITI in late 1991 (S. Hirai-K. Machida/ETL-NASDA)
- Reciprocal technical visits of 1992, followed by ETL proposal to MITI for multi-year funding (7/92)
- **NASA Code CD approval to JPL to proceed** with FY-93 planning for multi-year activity **(12/92)**
- **JPL TDO/IAO/Hq-IAO Coordination & Documentation Initiated (12/92)**
- **MITI approval to ETL to proceed** with Japan-FY93 start-up activity **(1/93)**
- JPL briefing of program to TRIWG "FY94 proposal" meeting (2/93)
- Code CD guideline approved for FY 94 task start at $350K (7/93)
- Draft MOU for collaboration prepared by JPL (cf. R. Dickinson/A. Jackson, IAO) (7/93)
- JPL visit to ETL re: draft technical collaboration planning & MOU iteration (7/93)
- FY94 funding finalized, WPA/SRM prepared, draft TR Program Plan description issued (10/93)
- **Start of funded technical work was end-FY93 + 3 weeks** (10/11/93)
- ETL technical visitation and prelimary JPL-ETL technology/lab interfaces defined (10/93)
- **MOU** restructured per Japan-USA "Cooperative R&D for Sci.&Tech." format (11/93)

TECHNOLOGY DEVELOPMENT & DEMONSTRATIONS

I. TECHNOLOGY

- **Intelligent Viewing Control:** computerized planning/sequencing of multi-camera views which are fused with a calibrated 3-D virtual workspace presentation, to include software facilities for model-based iterative updating, and also interactive 3-D modeling (viz. , the capture of new workspace features, their rendering/presentation, and calibration)
- **Intelligent Motion Control**: a "teleprogramming" control mode which sustains teleoperation-like dexterity for complex tasks under long/intermittent time delays (2-10 secs) and provides a qualitative compensation/correction for positioning-alignment and contact-force variabilities at the remote site (the operator's manual interaction with a virtual task environment is symbolically interpreted to low-bandwidth, low-level sensor-referenced autonomous commands that are sequenced to the remote site, which itself has a simple autonomous corrective behavioral control in local force-position)

II. DEMONSTRATIONS / TESTS

- **FY 1994: Establish USA-Japan inter-operation** between JPL Telerobotic Operations & Intelligent Controls (*"TROPICS"*) Lab and ETL Interactive Interface Systems Lab , viz., verify communication/formats for data/video/controls, and functionally test simple robot operations (**no Level 1 Milestone**)
- **FY 1995: Perform a JPL->ETL dexterous space assembly demo** (truss deployment of solar-powered ORU) integrating basic functions of Intelligent Viewing Control (**Level 1 Milestone, 9/95**)
- **FY 1996: Perform a ETL->JPL servicing in constrained environments demo** (obstructed ORU visualization, access & maintenance) integrating basic functions of Intelligent Motion Control (**Level 1 Milestone, 9/96**)

TECHNOLOGY DEVELOPMENT SUMMARY

MicroDexterity Systems, Inc.
- medical market vendor
- micro/minimally invasive surgery
- retina vitreous surgery leader
- viewing/imaging systems
- light/small surgery tools
- Operating Room automation
- horizontal integrator (in OR)
- clinical/hospital practicioner

Medical Market Capture
- microsurgery application tools
- precision robotic positioning
- *surgical dexterity enhancement*
- *operations at smaller scale*
- *new microsurgical procedures*
- augmented surgical viewing
- reduced surgeon workload
- smart "OR" interfaces

NASA - Jet Propulsion Lab
- high-d.o.f. robots/controls
- robot control mechanization
- robot sensors/user displays
- calibrated 3-D stereo/graphics
- teleoperator systems/masters
- teleoperation benchmarks
- robotic automation & user i/f
- telerobot system integration

Third Party Collaborations
- Ongoing Collaborations: Sandia National Labs/DOE (CR&DA), University of Washington (Grad. Rsch. Sponsor)
- Fabrication: Brush-Wellman, Delta Tau Data Systems, Sava Industries, EPM, Western Servo Designs, et al.
- Field Evaluation: Baptist Hospital, Center for Retina Vitreous Surgery (Memphis, TN); Medical Adcom, FDA
- Database & Benchmarks: ARPA/Biomedical, DOE, NASA, NIH/DHHS, NIST, et al.

FY 1994 Capabilities
- 4-dof micro-positioner: working concept design
- 6-dof robot slave & engineering benchmarks

[1-3:1 position dexterity]

FY 1995 Capabilities
- 6-dof master-slave (M/S): simulated surgery
- MDS breadboard work-station (2x6-dof, stereo)

[6-dof (S) design to OEM]

FY 1996 Capabilities
- Master-slave force controls and auto-positioning
- Clinical trials/database for 6-dof. master-slave

[M/S μ-dexterity robot]

FY 1997 Capabilities
- Intraoperative imaging assists & 3-D displays
- Operating Room retina vitreous procedures

[μ-surgery M/S to OEM]

MDS HIGHLIGHTS

MicroDexterity Systems, Inc. (Memphis, Tennessee)

***Steve Charles*, M.D., CEO; also, Director, Center for Retina Vitreous Surgery, and Clinical Medical Faculty for Opthamology/BioEngineering, University of Tennessee**

- World leader in vitreo-retinal surgical applications, with over 16,000 operations
- 20+ patents and prior successful ventures in microsurgery, with $250M sales to date
- MDS founded 1989, $ 4.0M venture-matching funds committed to project
- Highly qualified resident staff (former Bell Labs et al.), outstanding user and marketing alliances
- MDS documentation submitted to NASA includes
  - letter-of-interest & qualification sheet
  - corporate finance sheet & market projection (1993 - 1997)
  - supporting letters from interested medical users
  - medical advisory board
  - draft statement of work (prior art, market study, new product definitions, user requirements, technology-commercialization/market-development path & third party vendors, clinical testing & certification strategy, etc.)
  - concept design drawings, and photo-documentation for existing concept models
- MDS concept breadboard exists, and transfers to JPL 1/93 as 6-d.o.f. slave device/assemblies for engineering analysis (Technology Cooperation Agreement is established with MDS sign-off)

GROUND OPERATOR ENVIRONMENT FOR SSF TELEROBOTICS

APPROACH, USER & BENEFITS

APPROACH

- DESIGN, DEVELOP AND DELIVER A GROUND OPERATIONS TELEROBOTIC WORKSTATION, INTEGRATED FOR USE WITH THE JSC ARMSS SPDM-EMULATOR, AND HAVING CONSISTENT USER I/F & OPERATOR CONVENTIONS
  - Reflect SSF-baseline architecture constraints, operational time-delay, and sensory communications limits
  - Provide integrated instrumentation/computer-aids for task set-up & calibration, operator training, data recording
  - Support experimental design for subject testing & technology evaluation (*by the Astronaut Corps*)
  - Evaluate: ORU-changeouts, per standard Orbital Maintenance Instructions (OMI); also, remote inspection options
  - With TRIWG consensus, foster the workstation design conventions as a standard for further related Code C work
- PROGRESSIVELY ADD ADVANCED TECHNICAL CAPABILITIES TO THE INTEGRATED ARMSS WORKSTATION:
  - Modeling & operator-interactive simulation/planning of robot tasks
  - Graphics task preview & high-fidelity task visualization
  - Automated inspection & intelligent (computer-driven) camera control
  - Automated sequence generation & supervisory control
  - Time-delay predictive control (manual & supervisory), with error monitoring
- EVALUATE CAPABILITY OF THE RESULTING GROUND OPERATOR ENVIRONMENT, IN CONJUNCTION WITH EVOLVED ARMSS ROBOT CONTROL, TO MANAGE AND RESOLVE SIMULATED TASK ANOMALIES

USER & BENEFITS

- JSC's AUTOMATION & ROBOTICS DIVISION (POC: R. BERKA)
- SSF MISSION OPERATIONS (JSC) AND THE SSF PROGRAM (POC's: M. GERSH, J. PARRISH)
- OPERATIONAL BENEFITS INCLUDE
  - Increased SSF productivity and science return
  - Reduced crew fatigue and EVA hazards

In-Space Robotics Challenges

Technical Thrusts

- 1. Automated operation of remote dexterous robots from the ground
- 2. Compilation and concatenation of robot skills
- 3. Instrumented end effectors with improved dexterity
- 4. Object verification and pose refinement
- 5. Sensory skins for obstacle avoidance
- 5. Safe and robust control of manipulator/ environment interaction (e.g. compound manipulators, fault tolerance)

Planetary Rover Challenges

Technical Thrusts

- 1. Real-time perception and goal identification
- 2. On-board placement of science payloads and rock coring
- 3. Sparse terrain mapping
- 4. Systematic benchmark experiments (e.g. legs vs. wheels)
- 5. Fault tolerance and error recovery
- 6. Autonomous navigation over the horizon

Occupational and Micro-Environmental Research: Applications to Performance and Space Operations.

Gerald P. Krueger, Ph.D.
U.S. Army Research Institute of Environmental Medicine
USARIEM
Natick, MA 01760-5007

Presented to:

Space Technology Interdependency Group (STIG)
Space Operations Committee
Program Review Meeting
NASA Johnson Space Center, Houston, TX

3 Feb 94

Commander's Presentation of USARIEM Capabilities. COL Krueger, Commander of USARIEM, presented a 45 minute talk on the overall capabilities of the USARIEM, and highlighted particular areas of research expertise which either are at present, or potentially could be applied to NASA Space operational questions and problems. USARIEM actively seeks and covets interactive problem solving and collaborative research with NASA components. COL Krueger's talk was meant to stimulate possible joint work.

Mission. The U.S. Army research Institute of Environmental Medicine (USARIEM) at Natick, MA conducts basic and applied research to determine how exposure to extreme heat, severe cold, high terrestrial altitude, nutrition, task oriented work, physical training, and deployment operations affect soldiers's health and performance. soldiers' life processes, performance, and health. The principal goal is to elucidate complex interactions of environmental stress and the body's defense mechanisms. From such information we propose, develop and evaluate techniques, equipment, and procedures most effective in ensuring that soldiers are operationally effective.

Other goals include developing biomedical techniques to sustain health and enhance soldier performance through advances in physical fitness, exploiting nutritional strategies, pharmacological interventions, ergogenic aids, and other novel biotechnological approaches. Additionally, the Institute conducts physiological assessments of medical defense measures to protect against chemical battlefield threats.

USARIEM research provides critical information to benefit tactical commanders and their troops by reducing and eliminating judgement errors when conducting military operations in harsh climates and battlefield environments.

Information on environmental physiology, work-rest cycles and tables of hydration developed by this Army research organization can be included in force-on-force analyses, modeling, and simulation exercises to reduce errors in under- or over-estimation of warfighter capability to enhance the intelligence preparation of the battlefield and course of action analyses.

Organization. USARIEM has three research directorates: Environmental Pathophysiology, Environmental Physiology and Medicine, and Occupational Health and Performance (Organizational chart attached). These Directorates conduct technology base research, accentuate multidisciplinary approaches to problem solving, and seek out collaborative work with intra-service, inter-service, and other governmental organizations, like NASA, to accomplish USARIEM's mission.

Application to NASA and Space Research. Select aspects of USARIEM research have potential for direct application to resolving space operations problems identified by NASA. These include:

1) Bodily Thermoregulation. Astronauts must perform strenuous exercise (about 250 watts, during space shuttle extravehicular activities, or EVA, and probably higher during space station construction) that could be limited by thermal strain. Astronauts exposed to prolonged weightlessness can experience deconditoning, dehydration, and hypovolemia, all of which adversely affect thermoregulation. USARIEM work includes study of several countermeasures that manipulate body water and vascular volumes, and studies of hydration and blood volume effects on human thermoregulation.

Some USARIEM work has direct application for development of approaches to maintain thermoregulatory and exercise capabilities during prolonged human presence in space. USARIEM scientists have extensively studied dehydration effects and several possible countermeasures including hyperhydration, plasma and erythrocyte volume expansion.

More details on USARIEM research for these NASA applications are cited in the SOAR 93 Conference Proceedings paper entitled: "Hydration and Blood Volume Effects on Human Thermoregulation in the Heat: Space Applications," by Sawka et al. (SOAR 1993).

2) Prediction Modeling of Physiological Responses and Human Performance in the Heat. There is potential for astronauts to experience significant thermal stress in several space flight scenarios.

During extravehicular activity (EVA), the liquid cooling garment worn with the shuttle Extravehicular Mobility Unit (EMU), provides adequate cooling capacity for most EVAs conducted at an average metabolic rate of 200 kcal/hr. It is thought to provide adequate cooling at metabolic rates up to 400 kcal/hr as well.

Astronauts are reported to become less heat acclimated, dehydrated, and maintain a state of hypohydration during sustained space flight, which alters their ability to effectively thermoregulate.

EVAs conducted by astronauts at sustained high metabolic rates while in a state of hypohydration and less heat acclimated, may present a thermal challenge and possible adverse consequences on crew member performance.

Under certain EVA scenarios, it would be desirable to identify preferred work/rest cycles to prevent large rises in body temperature, and to determine adequate protocols for fluid replacement.

During launch, re-entry and emergency egress, astronauts wear a Launch and Entry Suit (LES). A ventilation system circulates cabin air through the suit. There is potential for excessive heat strain while wearing the LES at high ambient temperatures especially during re-entry; higher metabolic rates could occur during emergency egress; and crew members who are in a state of hypohydration and less heat acclimated during re-entry or emergency egress could experience difficulties with heat strain.

USARIEM heat physiologists can use a tried and proven heat strain model to predict physiological responses as well as expected physical work/rest cycles, estimations of maximum single physical work time, and to determine hydration or drinking requirements for different NASA space work scenarios.

Illustrations of such prediction modeling by USARIEM specialists were presented graphically. Three scenarios, on pre-launch, launch, re-entry, landing, and emergency egress after re-entry and landing, were presented. These scenarios can be examined in detail in the SOAR 93 Conference Proceedings in the paper entitled: "Prediction Modeling of Physiological Responses and Human Performance in the Heat with Application to Space Operations" by Pandolf et al. of USARIEM (SOAR, 1993).

3) Training Programs to Maintain Muscle Function in Space. The research staff in USARIEM's Biomechanics Laboratory have extensive experience and expertise in resistance training for improving and maintaining muscle strength and power. Two USARIEM biomechanists are certified as Strength and Conditioning Specialists by the National Strength and Conditioning Association. Both have published widely on resistance training.

USARIEM biomechanists could conduct experimentation leading to developing exercise programs that would prevent loss of muscle function and bone mineralization in outer space.

4) Circadian Rhythm and Acceptable Pharmacological Assistance in Stabilizing Sleep and Work/Rest Schedules in Space. USARIEM has considerable research and practical application experience in the topic of sustaining cognitive performance in extensive work-rest schedules necessitating significant loss of sleep, and in attempting to overcome jet-lag or shift-lag effects of circadian desynchronosis. Recent work using oral administration of melatonin (a pineal gland hormone emitted in the dark) with Army aviation crews in adjusting to transmeridian flight offers promise in adjusting astronaut work and sleep schedules in orbital or in long term inter-planetary space flight. Such experimental research could be proposed individually, or collaboratively.

5) Food Technology Space Flight. USARIEM nutrition researchers work very closely with the experts in the DoD's Food Technology and Food Engineering Development Program, co-located at the Natick Research, Development and Engineering Center (NRDEC).

COL Krueger showed a series of slides highlighting NRDEC's long history of space food development programs. Natick designed and produced foods for the earliest manned space flights in the 1960s (Mercury and Gemini). Early space foods included semisolid foods in collapsible aluminum tubes (Tube Foods) such as applesauce, peaches, beef and vegetables, as well as bite sized compressed and dehydrated foods with edible coatings.

During the 1970s Natick developed food for Apollo Saturn and Apollo Soyuz. For Skylab, Natick provided technical assistance in preparing food specifications. Foods developed by Natick for these and present day space flights include freeze dehydrated, compressed, thermostabilized, intermediate moisture and irradiated products. Irradiation as a method of food preservation was pioneered at Natick. Individual servings of irradiated beef steak, ham, corned beef and turkey were specifically produced at Natick for the Apollo Soyuz flight. These items and other irradiated products were used on early Space Shuttle flights.

The Space Transportation Systems (STS) Space Shuttle fights were initiated in 1981 and continue today. Natick continues to provide assistance to NASA with food specifications, consultation and evaluation of foods and packaging systems applicable to space feeding. Natick advises NASA on new lightweight packaging, and shelf stable foods developed for use in military rations, as well as advances in packaging, preservation and food technologies. Presently, selected Meal-Ready-to-Eat entrees and snack items are used in Space Shuttle menus.

During FY 91, Natick developed a Safe Haven Food System for the Space Station Freedom. This is a nutritionally complete, shelf stable, 45-day contingency food supply to be used if timely resupply cannot be achieved.

A Memorandum of Agreement for exchange of technology between NASA and Natick R,D&E Center was signed in FY 92. Natick resumed R&D of irradiated foods for use by the military, NASA, and the commercial sector. Natick continues to provide assistance, consultation and technology exchange with NASA on military and space food systems. (POCs at Natick RDEC are: Judith M. Aylward and Philip Brandler, PH: (508) 651-4448.

6) USARIEM Nutrition Research and Diet Recommendations for Space Flight. USARIEM employs a sizeable staff of research nutritional biochemists and nutritionists. Practical outcomes of our research include advice and consultation on diet selection for various specialized military work scenarios, especially in arduous work settings, like harsh climatic extreme environments. USARIEM nutrition research programs and findings can readily be applied to selection of appropriate nutritional diets for astronauts, especially to meet requirements of long term space flight.

USARIEM Commitment to STIG-SOC and to Collaborative Space Oriented Research with NASA. As Commander, USARIEM, COL Krueger has brought the enthusiasm of USARIEM's research staff to the table at STIG-SOC. We are committed to it. We pledge to engage in consultation, assistance, collaborative research, or customer funded research projects for NASA components, and we welcome the invitation to work together. Give us a call: (508) 651-4811.

GERALD P. KRUEGER
Colonel, US Army
Commanding

DEPARTMENT OF THE ARMY

U.S. ARMY RESEARCH INSTITUTE OF ENVIRONMENTAL MEDICINE

NATICK, MASSACHUSETTS 01760-5007

THIS IS NOT AN OFFICIAL ORGANIZATIONAL CHART

MILITARY DETACHMENT

DETACHMENT COMMANDER, SGRD-UE-ADJ — CPT C. BURTON 5127
DETACHMENT NCOIC, SGRD-UE-ADJ — SFC R.W. DICKINSON 5125
PSNCO, SGRD-UE-ADJ — SSG C. DOUGLAS-SANDERS 5133

OFFICE OF THE COMMANDER

COMMANDER, SGRD-UE-ZA — COL G. P. KRUEGER 4811
DEPUTY COMMANDER, SGRD-UE-ZB — LTC(P) G. C. LINDSAY 4811
EXECUTIVE OFFICER, SGRD-UE-ZX — MAJ B. J. FREUND 4812
CHIEF MEDICAL NCO, SGRD-UE-NCO — SFC R.W. DICKINSON 5125

SPECIAL STAFF

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FACILITIES MANAGER, SGRD-UE-RPB — MR. J. M. FOSTER 5138
PUBLIC AFFAIRS / INFORMATION — DR. M. P. HAMLET 4865
ADJUTANT, SGRD-UE-ADJ — CPT C. BURTON 5127
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ACTING INSPECTOR GENERAL, SGRD-UE-RPP — MAJ H.E. MODROW 4850

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NCOIC — SSG D. R. Patterson 4264

CELLULAR PHYSIOLOGY & PATHOLOGY DIVISION (SGRD-UE-EPP)
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NCOIC — SGT P. OGLE 4862

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NCOIC — SGT D. BIRON 4861

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NCOIC — SGT B. MOORE 5607

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CHIEF — CPT C. WATSON 4866

BIOENGINEERING BRANCH (SGRD-UE-RPB)
CHIEF — MR. J. M. FOSTER 5138/4804

PLANS & OPERATIONS BRANCH (SGRD-UE-RPP)
CHIEF — Vacant 5607

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BIOPHYSICS & BIOMEDICAL MODELING DIVISION (SGRD-UE-EMB)
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NCOIC — SFC G. J. Busque 4891

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LOGISTICS BRANCH (SGRD-UE-ASL)
CHIEF — CPT B. Cruse 4808/4810

RESOURCES MANAGEMENT BRANCH (SGRD-UE-ASM)
CHIEF — MS. V. M. TRAINER 5137
Personnel — Ms. M.E. Stephens 4821

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NCOIC — SSG J.S. Gamble 5128

MILITARY PERFORMANCE & NEUROSCIENCE DIVISION (SGRD-UE-OPS)
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NCOIC — SSG D.I. Welch 4822

OCCUPATIONAL MEDICINE DIVISION (SGRD-UE-OPM)
CHIEF — LTC B. H. JONES 4887
NCOIC — SGT R. Hoyt 4847

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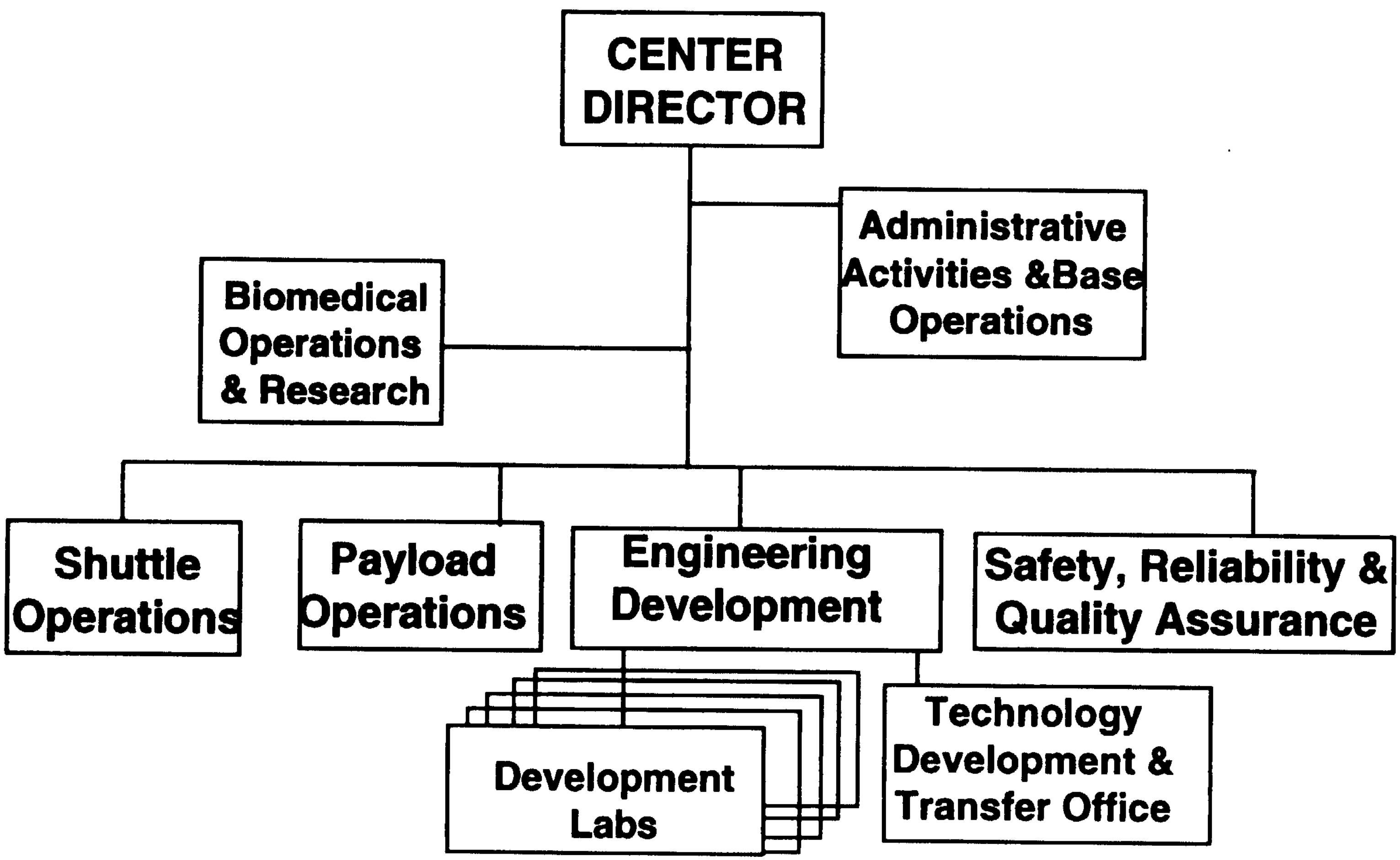
NASA
Kennedy Space Center Advanced Technology Program

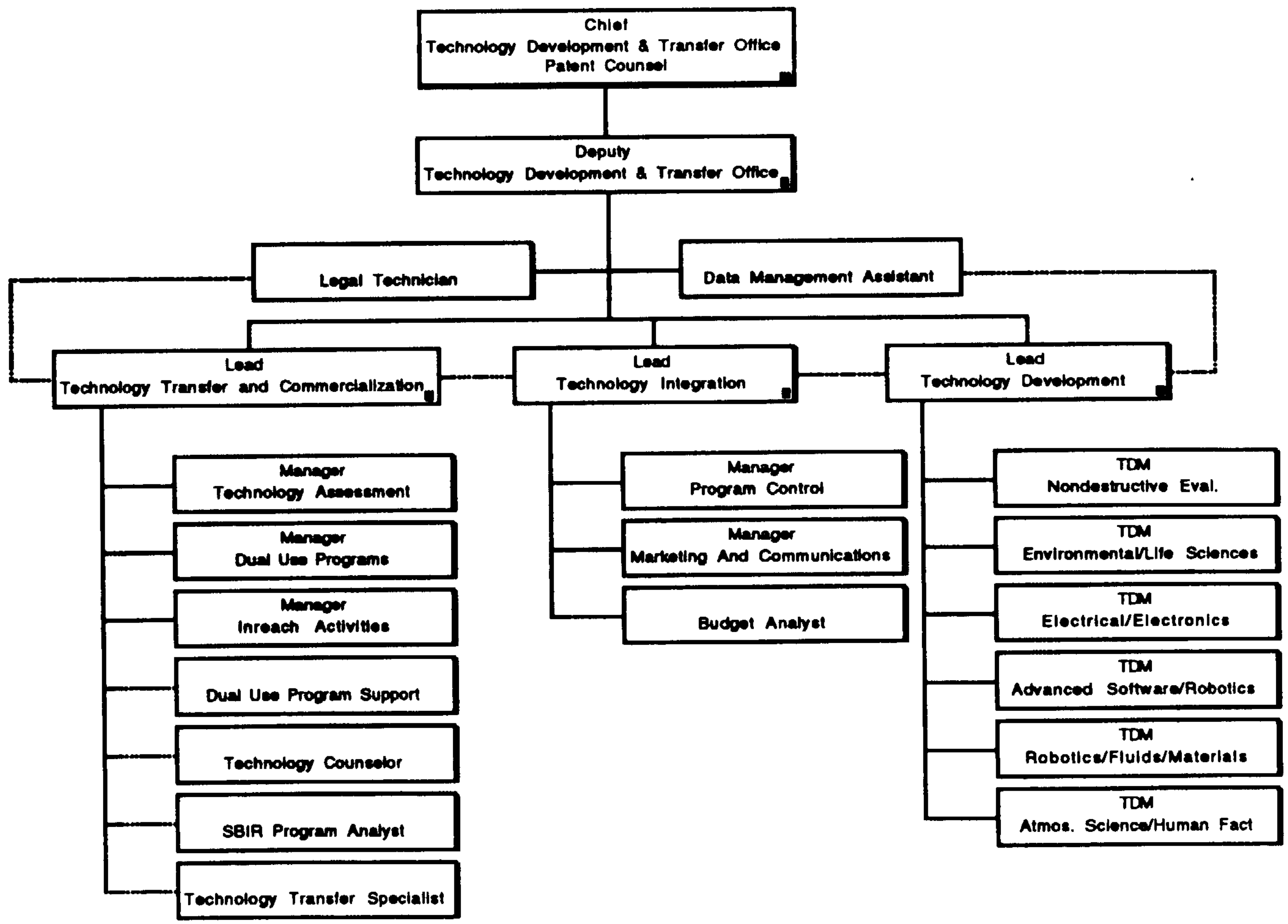
SOC Programmatic Review Meeting, 3-4 February '94

Manager of Dual Use Programs
DE-TDO
KSC
Karen Gebert Thompson

NASA JOHN F. KENNEDY SPACE CENTER (KSC) ORGANIZATION
(Very simplified)



TECHNOLOGY DEVELOPMENT AND TRANSFER OFFICE



ADVANCED SOFTWARE

FOCUS:

- Development of advisory/expert systems for health monitoring, diagnosis, prognosis and problem resolution for Shuttle and Ground systems.
- Software architectures for integrating and distributing both conventional and intelligent systems.
- Scheduling systems to assist in optimization of vehicle processing activities.
- Multimedia and conventional content data base management systems.

JUSTIFICATION:

- Cost avoidance by improving efficiency and autonomy of ground processing operations.
- Dual use technologies - Provide base for industrial applications.

ROBOTICS

FOCUS:

- Shuttle, Payload, and Facility maintenance tasks, particularly hazardous or tedious tasks.
- Shuttle & Payload inspection tasks, particularly enabling inspection of heretofore unobservable areas, and automated interfaces to trend analysis databases.

JUSTIFICATION:

- Improve safety in conducting hazardous operations.
- Practical testbed for proof of robotic technology in NASA ground operations before deployment in space or by industry.
- Cost avoidance through more efficient ground operations.

MATERIALS SCIENCE

FOCUS:

- Improvement of methods for construction, maintenance and repair of ground processing facilities as related to environmental stress and launch damage.
- Development of new generation protective gear for hazardous materials handling.
- Improvement of methods for quantitative analysis of Shuttle debris samples.

JUSTIFICATION:

- Unique environment of ground processing facilities.
- Dual use technologies - Many industrial inquiries.
- Payback comes in cost reductions for repair and refurbishment.

ELECTRONICS & INSTRUMENTATION

FOCUS:

- Advancements in sensor and transducer technology as well as the data acquisition and transmission systems which use them.

- Improvement in equipment and techniques used for testing the environment and ground support systems during ground processing.

JUSTIFICATION:

- Current intensive reliance on low-tech portable testing systems and antiquated sensor technology.

- Dual use technologies - Patent and industrial inquiries pending.

- Payback comes in cost reductions due to improved efficiency in test data acquisition, equipment maintenance, manpower reductions, problem resolution.

NON-DESTRUCTIVE EVALUATION (NDE)

FOCUS:

- Imaging systems for electronic mold impressions and detection of subsurface flaws.
- Application of NDE Technologies such as Computer Tomography to assist in logistics maintenance areas of the Shuttle.
- Reliability/accuracy improvement for critical bolt tensioning.

JUSTIFICATION:

- Limited current use of NDE techniques reduce reliability of Shuttle support methods.
- Dual use technologies - Rockwell and Lockheed technology utilization.
- Payback comes in less time to fabricate, increased reliability and increased component useful life.

FLUIDS

FOCUS:

- Development of smart fluid system components which will monitor health and failure trends.
- Improvement of leak-detection methods, including reliable H_2 leak sensors.

JUSTIFICATION:

- Fluid systems represent the highest cost and most hazardous operations of all vehicle systems.
- Dual use technologies - Possible patents on some equipment.
- Payback comes via risk reduction and reduced test requirements.

HUMAN FACTORS ENGINEERING

FOCUS:

- Apply industrial engineering techniques for operations analysis to determine areas where cost of ground processing operations can be reduced.
- Test application of state-of-the-art developments for applications into identified engineering areas.

JUSTIFICATION:

- Reductions in cost of operations through improved operational efficiency and productivity.
- Improved personnel safety including flight crew rescue capability.

ATMOSPHERIC SCIENCE

FOCUS:

- Weather detection, analysis and prediction -- particularly as related to lightning threat -- and dispersion of hazardous materials.

JUSTIFICATION:

- Weather scrubs numerically surpass all other reasons for launch vehicle scrubs and interruption of operations in work complexes.
- Dual use technology - Any advancements are of use to public through National and Commercial Weather Services.
- Payback comes in better prediction capabilities and reduction of false alarms.

IMPORTANT PROJECT COMPONENTS

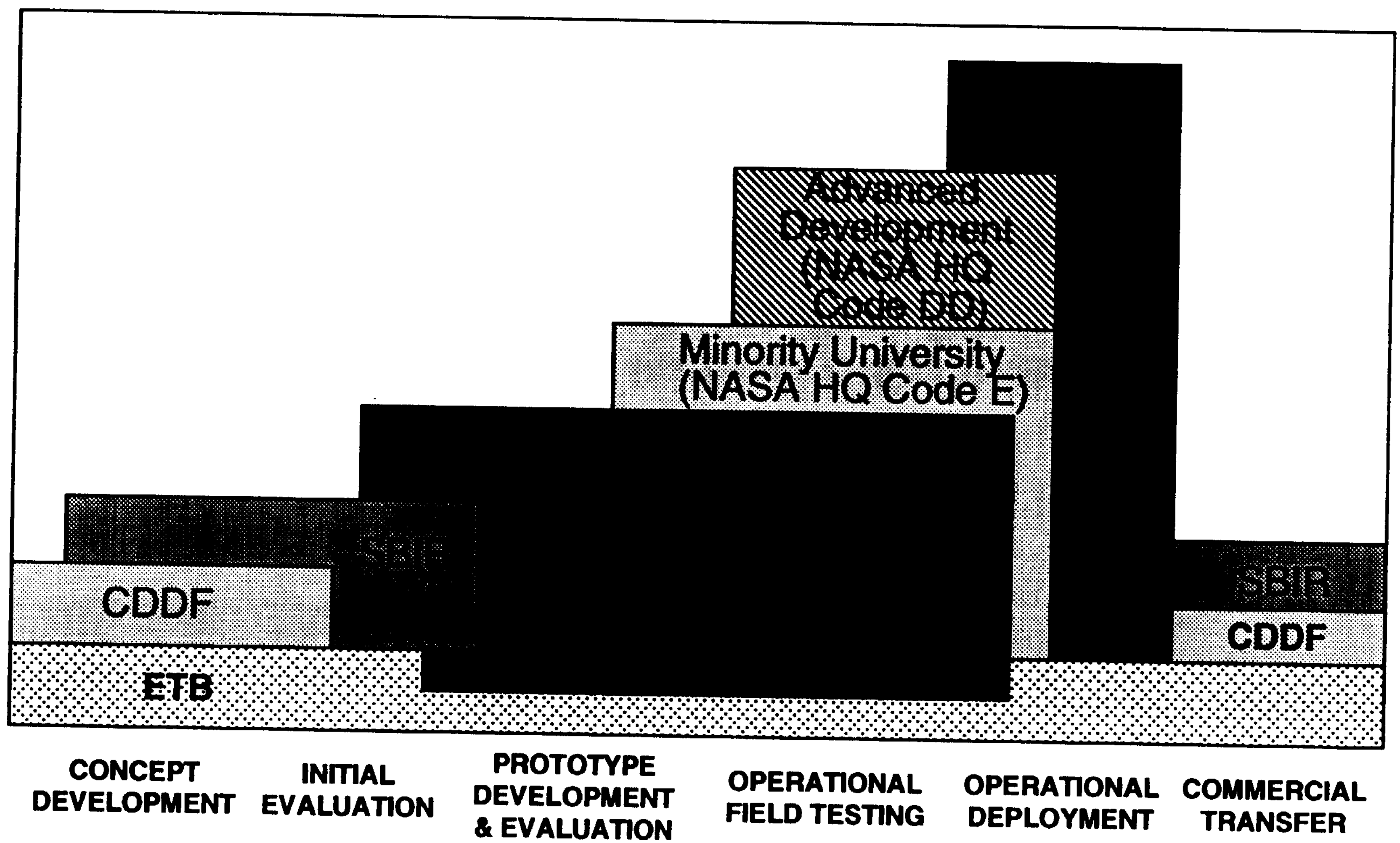
- End user (customer) involvement
- Leverage work previously done, or currently being done, in other projects and at other Centers.
  - Focus groups, workshops
  - Collaborations [i.e. Ames (MOU)* & Langley (MOU)*]
- Success metrics, quantitative measures of benefits
- Project implementation plans by customer
- Commercial Technology Transfer

*MOU = Memorandum of Understanding

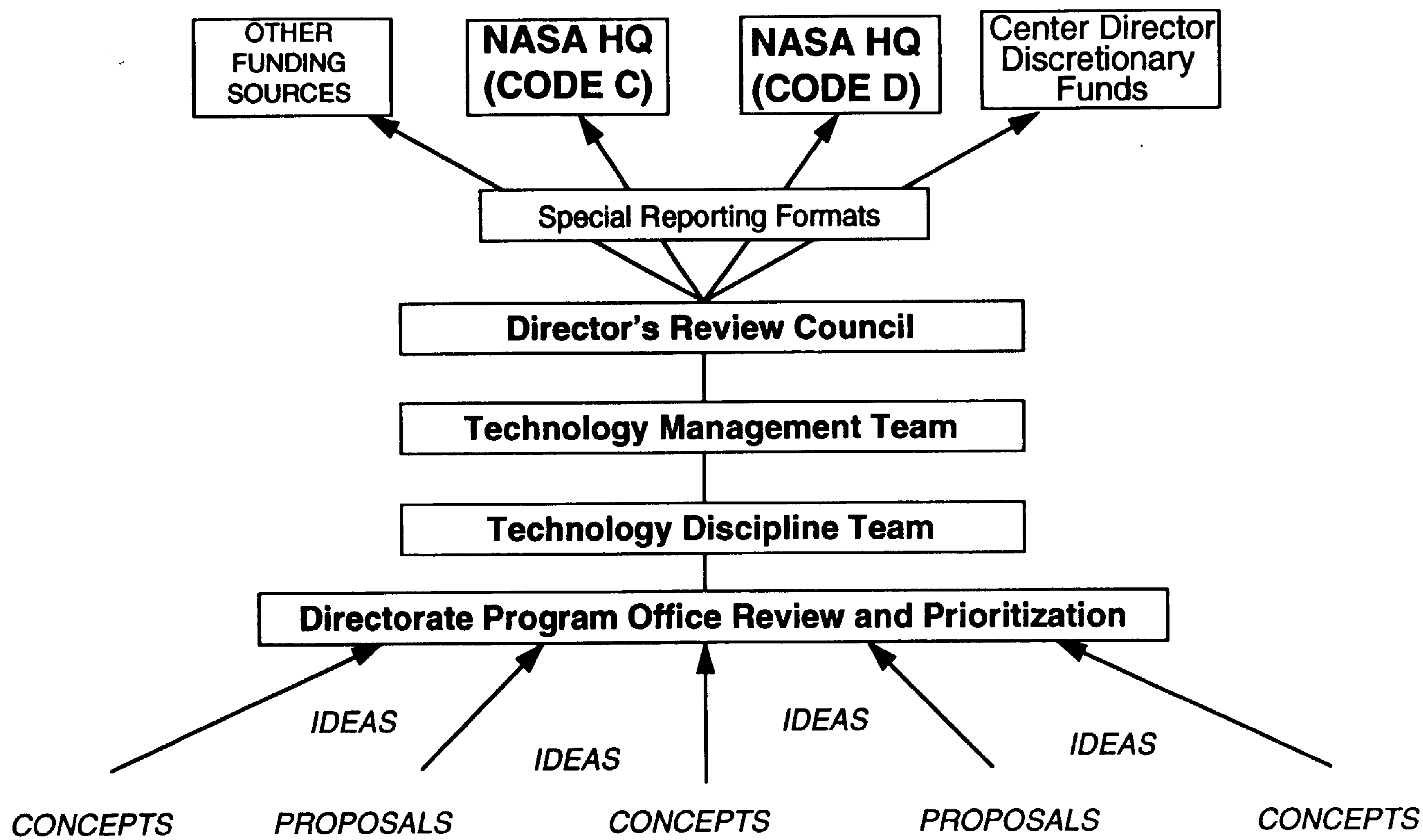
FUNDING SOURCES

- NASA HQ - Office of Advanced Concepts and Technology (Code C)
- NASA HQ - Advanced Program Office of the Office of Space Systems Development (Code DD)
- NASA HQ - Minority University Program Office (Code E)
- ETB (Engineering Technical Base = basic lab support) - NASA HQ (Code M)
- Center Director Discretionary Funding (CDDF)
- Shuttle Program
- Small Business Innovation Research (SBIR)

FUNCTIONAL FUNDING DISTRIBUTION



KSC REVIEW CYCLE



KEY PARTNERSHIPS

- KSC Design Engineering Laboratories
- KSC Directorate Program Offices
- KSC Contractors, including:
  - McDonnell Douglas Space Systems Company
  - Lockheed Space Operation Company
  - Rockwell International Corporation
  - I-NET
- NASA Ames (MOU)*, NASA Langley (MOU)*, and other NASA Centers
- Universities
- State of Florida Technological Research and Development Authority (TRDA)

* MOU = Memorandum of Understanding

KSC TECHNOLOGY TRANSFER OUTREACH ACTIVITIES

<u>Interface with Other Directorates at KSC</u>

Inreach Assistance Program seeks out resident technology with commercial potential in each directorate at KSC.

<u>Interface with other NASA Centers and Headquarters</u>

- Coordination between KSC and other NASA Centers has resulted in productive joint efforts.
- Collaboration with Headquarters and other NASA Centers has established key contacts for future coordination efforts.

KSC TECHNOLOGY TRANSFER OUTREACH ACTIVITIES

Interface with Other Federal Agencies

- Coordination between KSC and other federal agencies has resulted in joint technology transfer efforts.
- Collaboration with other federal agencies on technology transfer efforts generates new ideas regarding methods for improving technology transfer.

Interface with Universities, Industry, Other Government Agencies, etc., Through Consortia

KSC TECHNOLOGY TRANSFER OUTREACH ACTIVITIES

National Technology Reinvestment Projects (TRP) and Interagency Activities

- **Advanced Research Projects Agency/TRP**
- **Other Interagency Technology Investment Activities**
- **Advanced Technology Program, National Science Foundation, NASA**

Current Florida TRP

- **Center for Training and Simulation Alliance:**
  IBM, Dynamic Research, AT&T, DUAL Inc., Small Business Development Center, Institute for Simulation and Training, University of Central Florida, NASA, Naval Training System Division, Army Simulation and Training Command
- **Gulf Coast Alliance for Technology**

KSC TECHNOLOGY TRANSFER OUTREACH ACTIVITIES

Interface with State Agencies

- The State of Florida and NASA/KSC are partners in commercializing selected technologies for Dual Use.
- The KSC Technology Transfer Office is contacting other states to generate interest in setting up similar partnerships.

INNOVATIVE NASA/KSC AND FLORIDA PARTNERSHIP

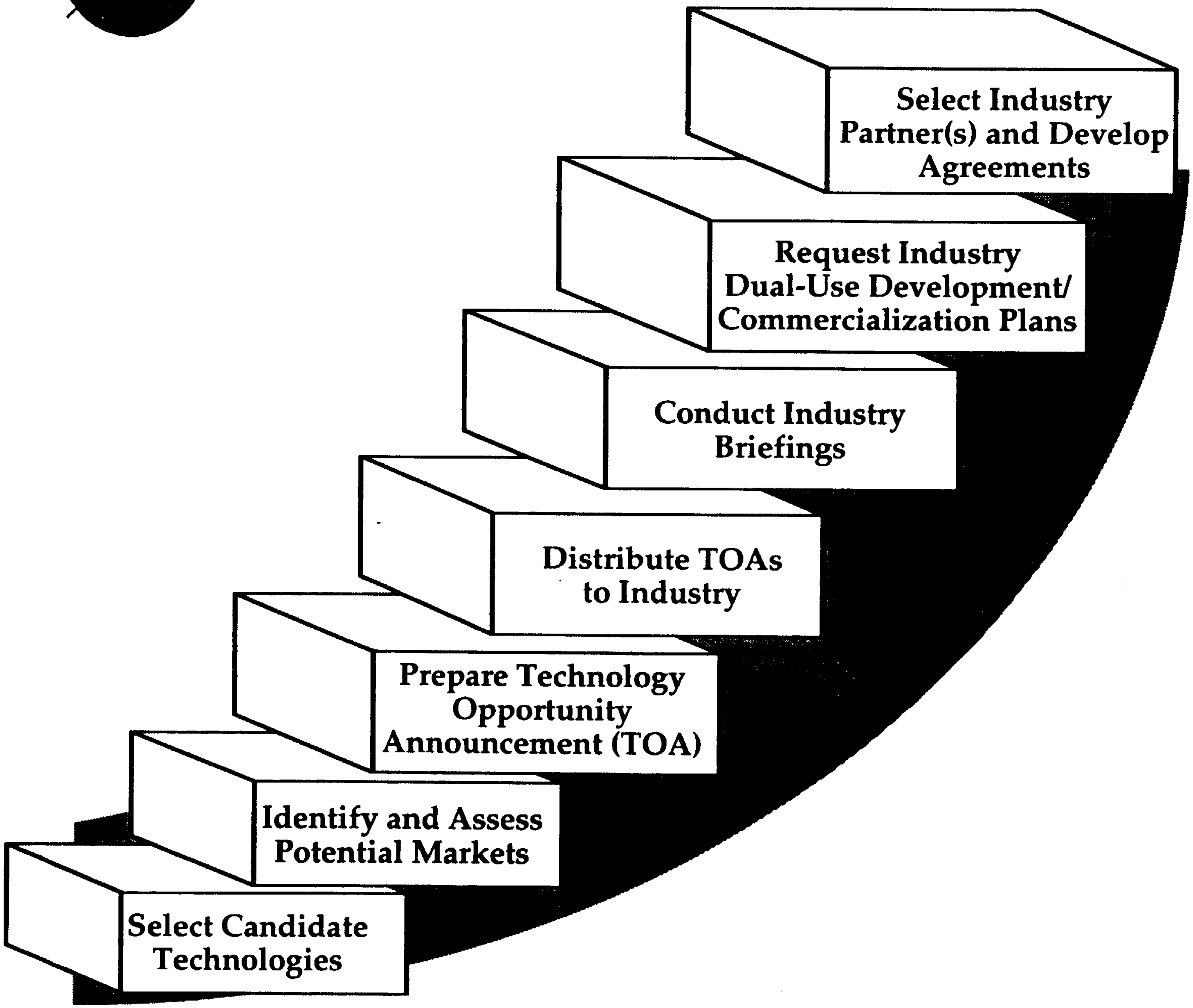
Purpose of Partnership Agreement:

Increase deployment of commercially viable technologies to meet KSC's needs as well as commercializing selected technologies.

Technology Partnership Involves:

- Florida industry partner provides a minimum of 25% of the total project cost
- State of Florida -- as represented by the Technological Research and Development Authority (TRDA) -- equally matches NASA funding of the project
- University within state of Florida
- NASA/KSC

Process to Develop Dual-Use Partnerships



NASA

ACTIVE DUAL USE PROJECT

UNIVERSAL SIGNAL CONDITIONING AMPLIFIER (USCA)

This project involves commercialization of USCA, a rugged and field-installable self- (or remotely) programmable amplifier that works in combination with a tag random access memory (RAM) attached to various types of transducers.

Eight qualified manufacturers attended a technical briefing in October 1993.

Several interested Florida manufacturers have submitted commercialization plans to the TRDA for evaluation in hopes of TRDA submitting an unsolicited proposal for Dual use commercialization to NASA/KSC.

ACTIVE DUAL USE PROJECTS

SUPERSONIC GAS-LIQUID CLEANING SYSTEM

An announcement of opportunity was prepared for a Supersonic Gas-Liquid Cleaning System developed by NASA/KSC engineers. The system was developed for cleaning and cleaning verification of hardware to replace current methods involving Chlorofluorocarbon-113 (CFC-113) rinsing.

Research Triangle Institute (RTI) conducted a market survey and sent announcements out nationally to prospective manufacturers in January 1994 .

Florida's TRDA sent announcements out to prospective Florida manufacturers.

A technical briefing is planned for all prospective industry partners on February 4, 1994.

TECHNOLOGY LICENSING ACTIVITY

Licensing of Inventions

In an effort to promote licensing activities, the following brochures have been developed for distribution at conferences:

I. *BUILD ON NASA SPACE TECHNOLOGY* which lists by title and patent number, inventions available for commercial licensing.

II. *LET'S MAKE A DEAL* which briefly describes how a license for using NASA - developed technology can be obtained.

KSC is also actively involved in initiating and managing a number of technology application projects for commercializing a variety of different technologies developed by both in-house and contractor employees. These projects will potentially result in the licensing of the inventions involved and the commercialization of these technologies.

TECHNOLOGY LICENSING ACTIVITY

<u>Licensing of Computer Software</u>

KSC has embarked on a new and unique activity to:

(1) contractually acquire title to contractor - developed computer software

(2) obtain copyright protection to the software.

(3) license companies and software houses to make the software available commercially.

TECHNOLOGY LICENSING ACTIVITY

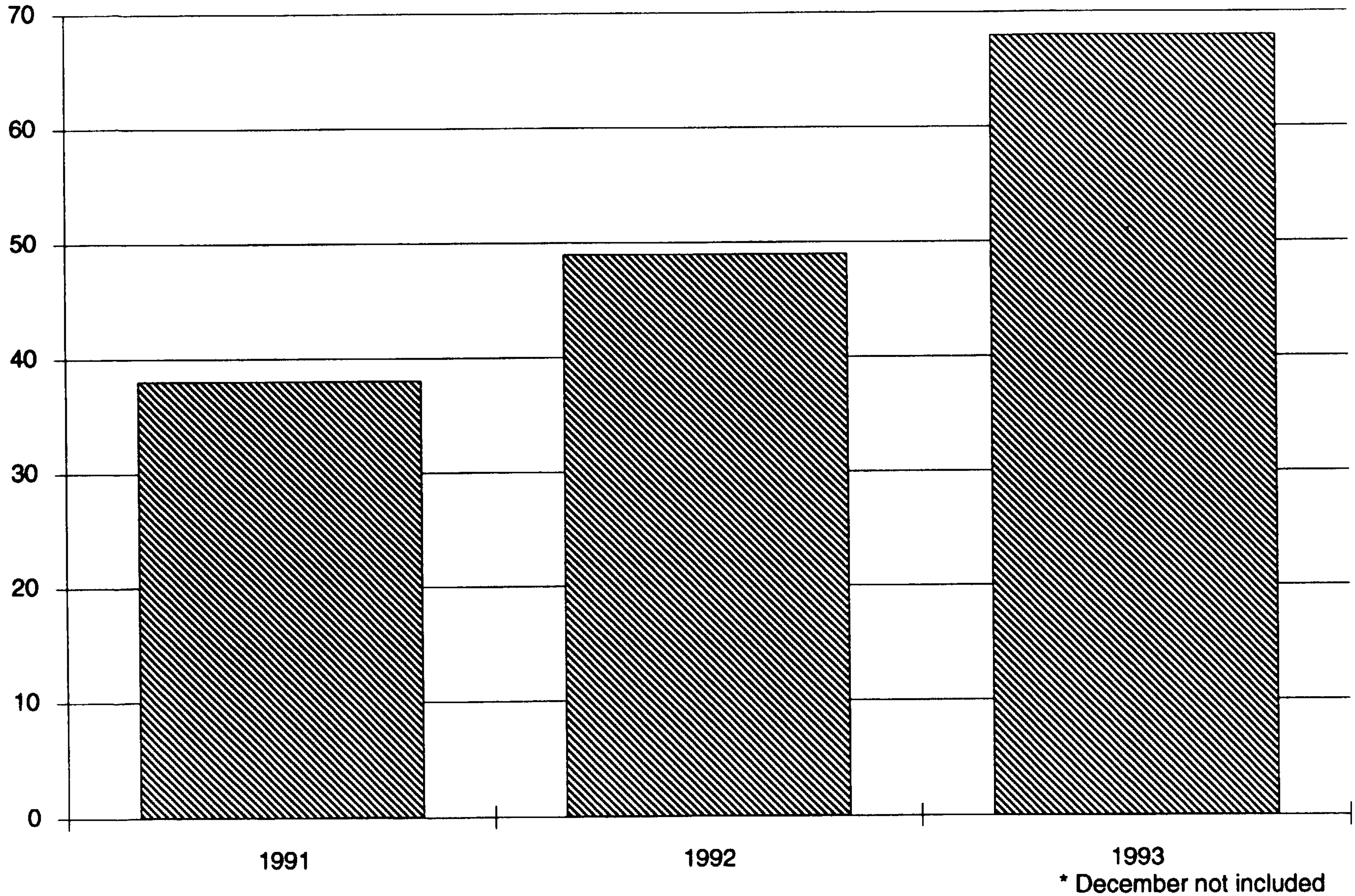
<u>Ground Processing Scheduling System (GPSS) License</u>

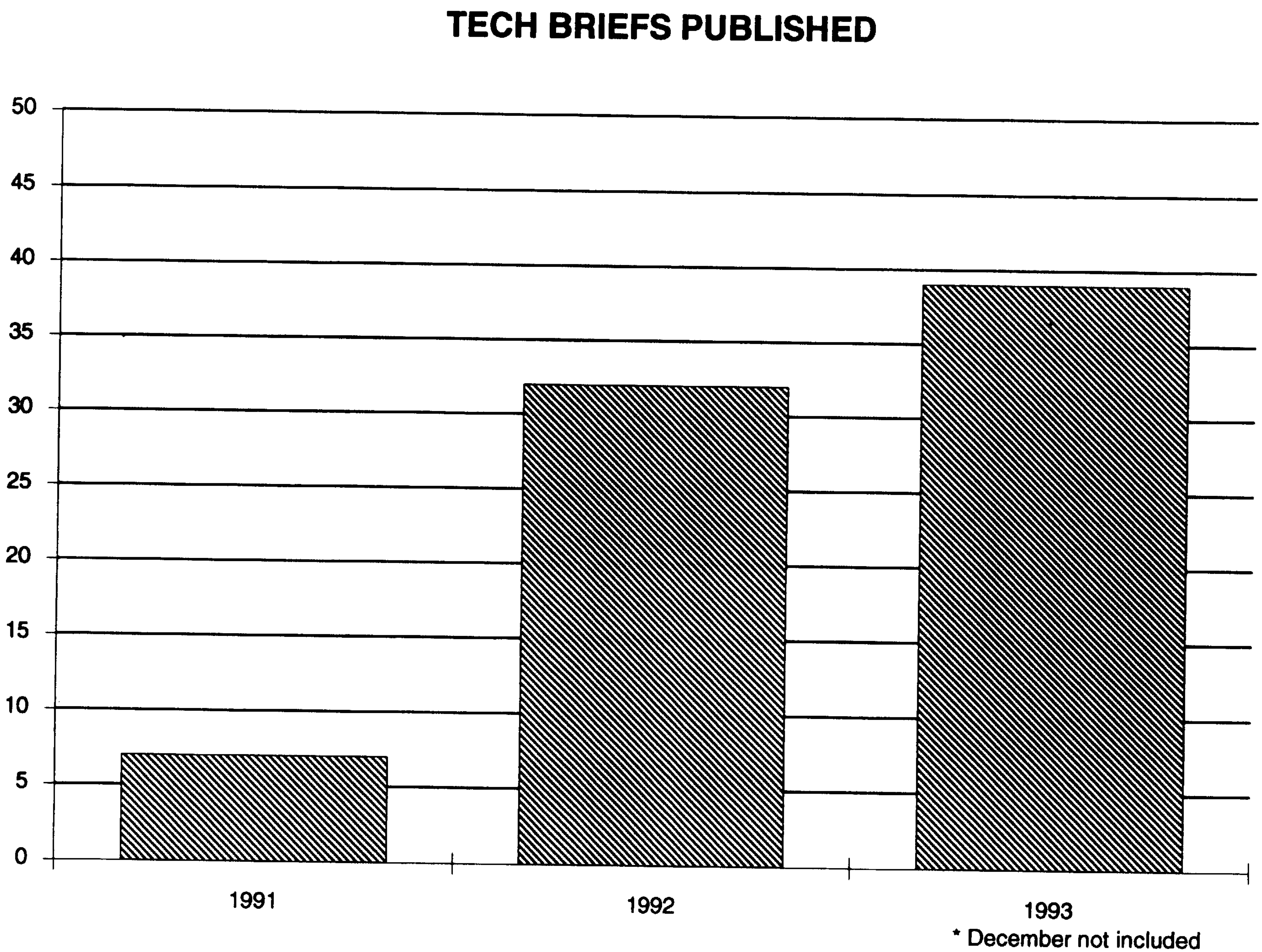
The GPSS was developed by KSC, ARC, and LSOC to schedule the numerous activities involved in the Ground Processing of the Space Shuttle. In 1993 a commercial software development company in California entered into a copyright license agreement with NASA to transition this technology to other areas having commercial applications. This License constituted the first NASA copyright license for commercializing computer software.

STATISTICAL STATUS OF NEW TECHNOLOGY ITEMS

The attached charts show the statistics for 1991,1992, and 1993 on New Technology Items.

NEW TECHNOLOGY ITEMS REPORTED




TECH BRIEFS PUBLISHED
50
45
40
35
30
25
20
15
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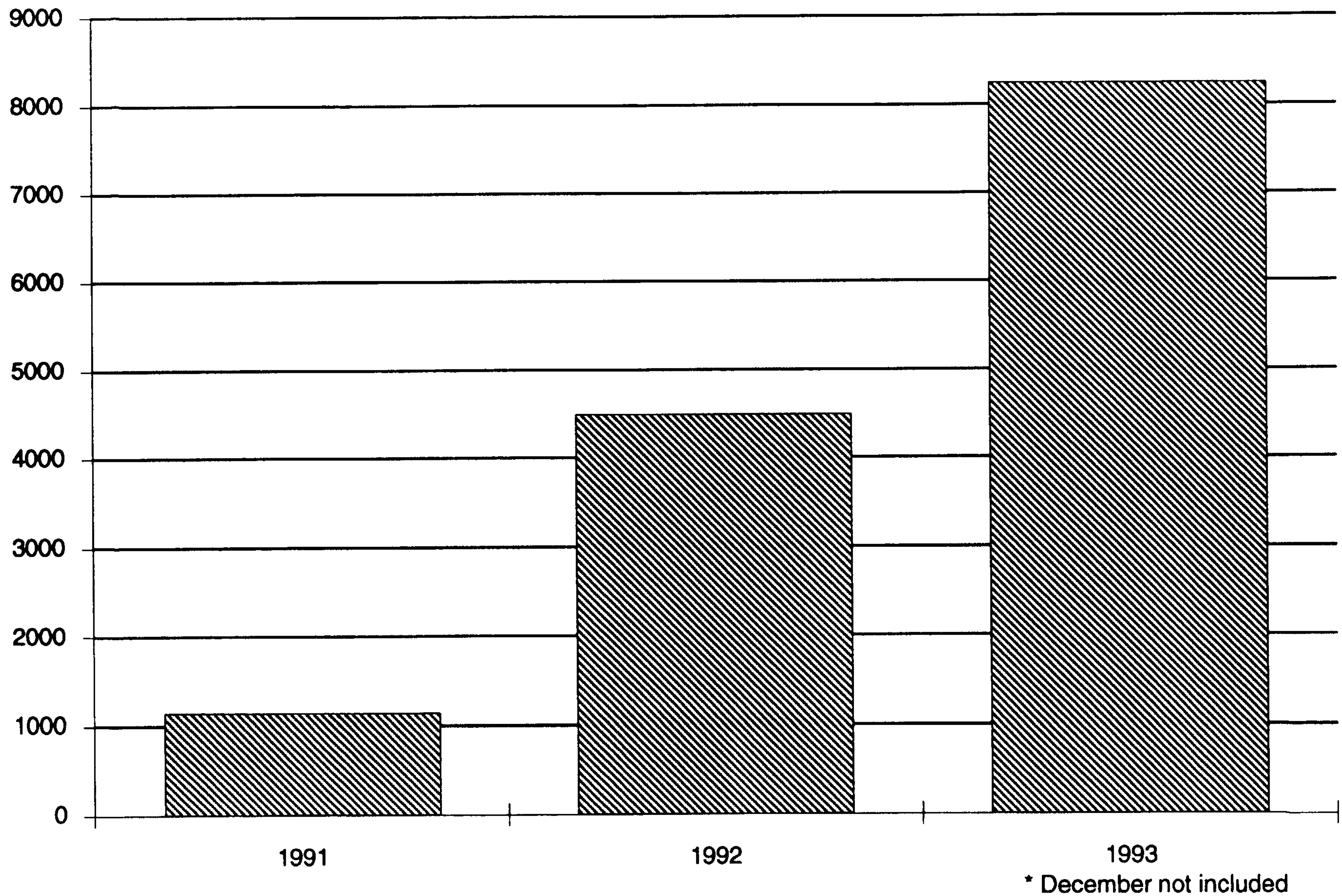
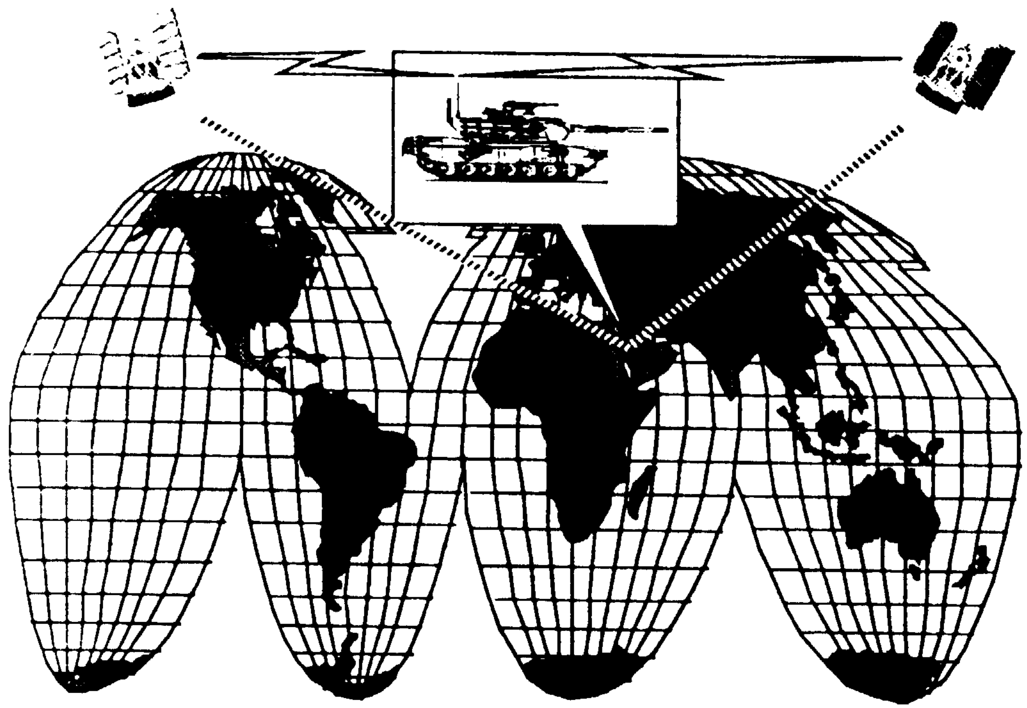
1991
1992
1993
* December not included

REQUEST FOR TECHNICAL SUPPORT PACKAGES (TSP)




SPACE... THE FINAL FRONTIER
FOR TERRESTRIAL SUCCESS

SPACE - THE ULTIMATE HIGH GROUND

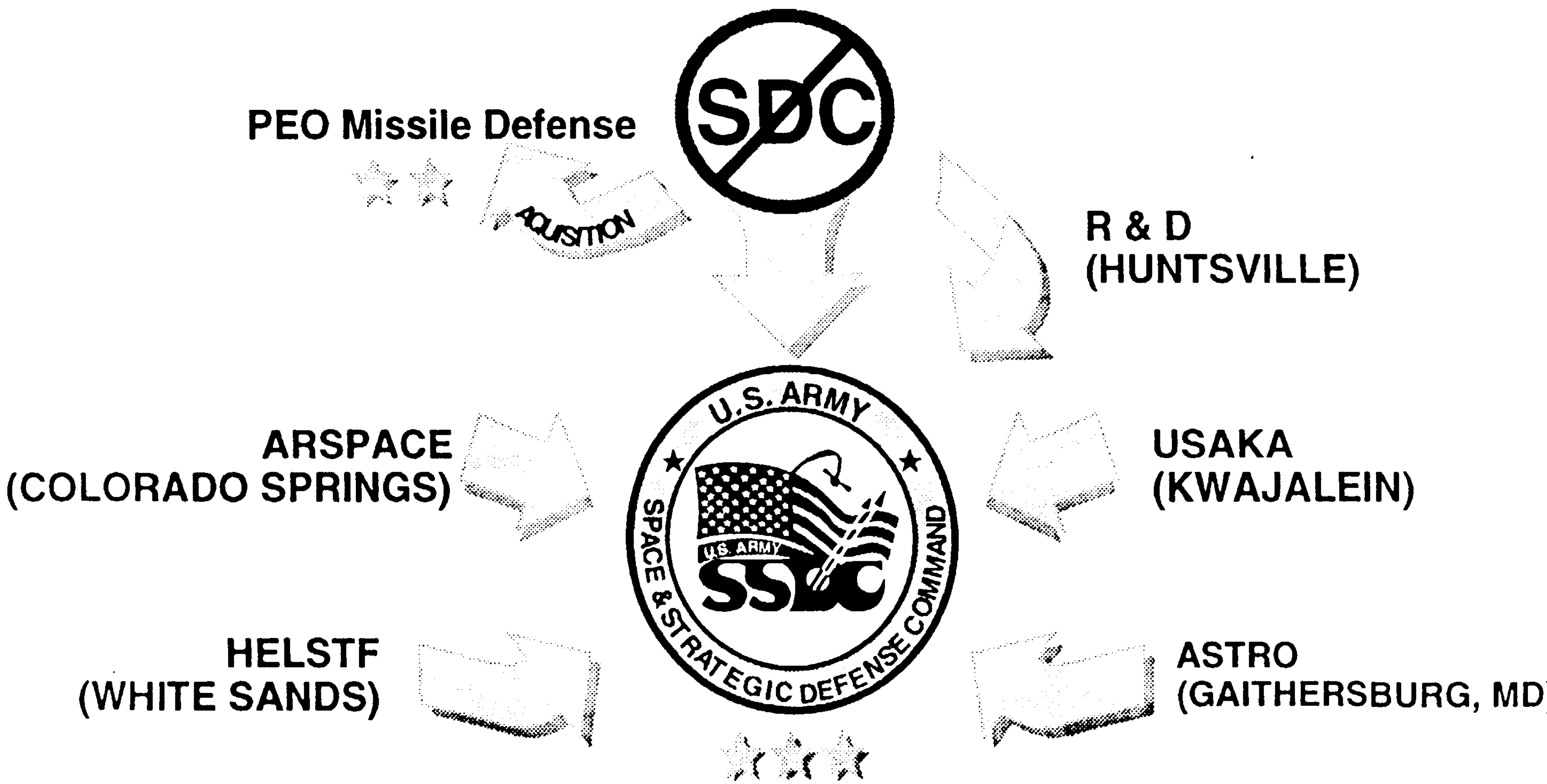


Space Products for the 21st Century Soldier

- ☑ Communications
- ☑ ELINT/COMINT
- ☑ Imagery
- ☑ Position/Navigation
- ☑ Missile Warning
- ☑ Weather/Terrain

ARMY MISSIONS DEMAND ASSURED ACCESS TO EXCELLENT SPACE PRODUCTS

ORGANIZED FOR THE FUTURE



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USASSDC MISSIONS

- Serve As Army Component Command Of U.S. Space Command
  - Operate Ground Based Component Of National Missile Defense When Developed
  - Army Proponent For Space Products
  - Operate DSCS Earth Stations

- Execute Ballistic Missile Defense Organization Research And Technology Missions
  - Provide Matrix Support To Program Executive Officer - Missile Defense
  - Manage Huntsville Missile Defense Tech Base

- Operate National Range At Kwajalein Atoll

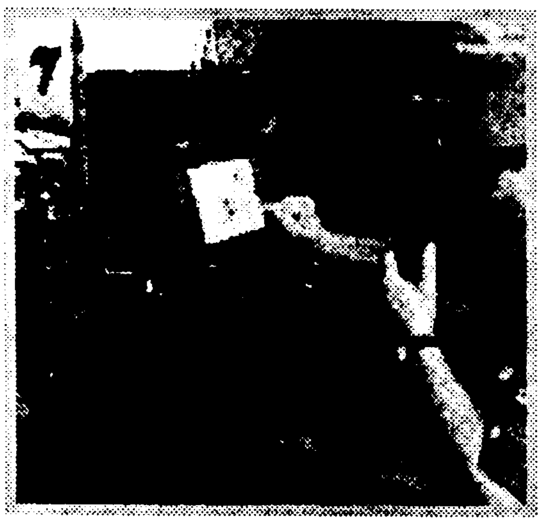
- Operate Laser R&D Facility At HELSTF

SPACE APPLICATIONS TECHNOLOGY PROGRAM

MISSION

- MANAGE ARMY SPACE TECHNOLOGY INTEGRATION
- SERVE AS THE ARMY'S SPACE TECHNOLOGY FOCAL POINT
- FOCUS ARMY SPACE RESEARCH TOWARD SUPPORT TO WARFIGHTERS
- CONDUCT SPACE TECHNOLOGY APPLICATION DEMONSTRATIONS

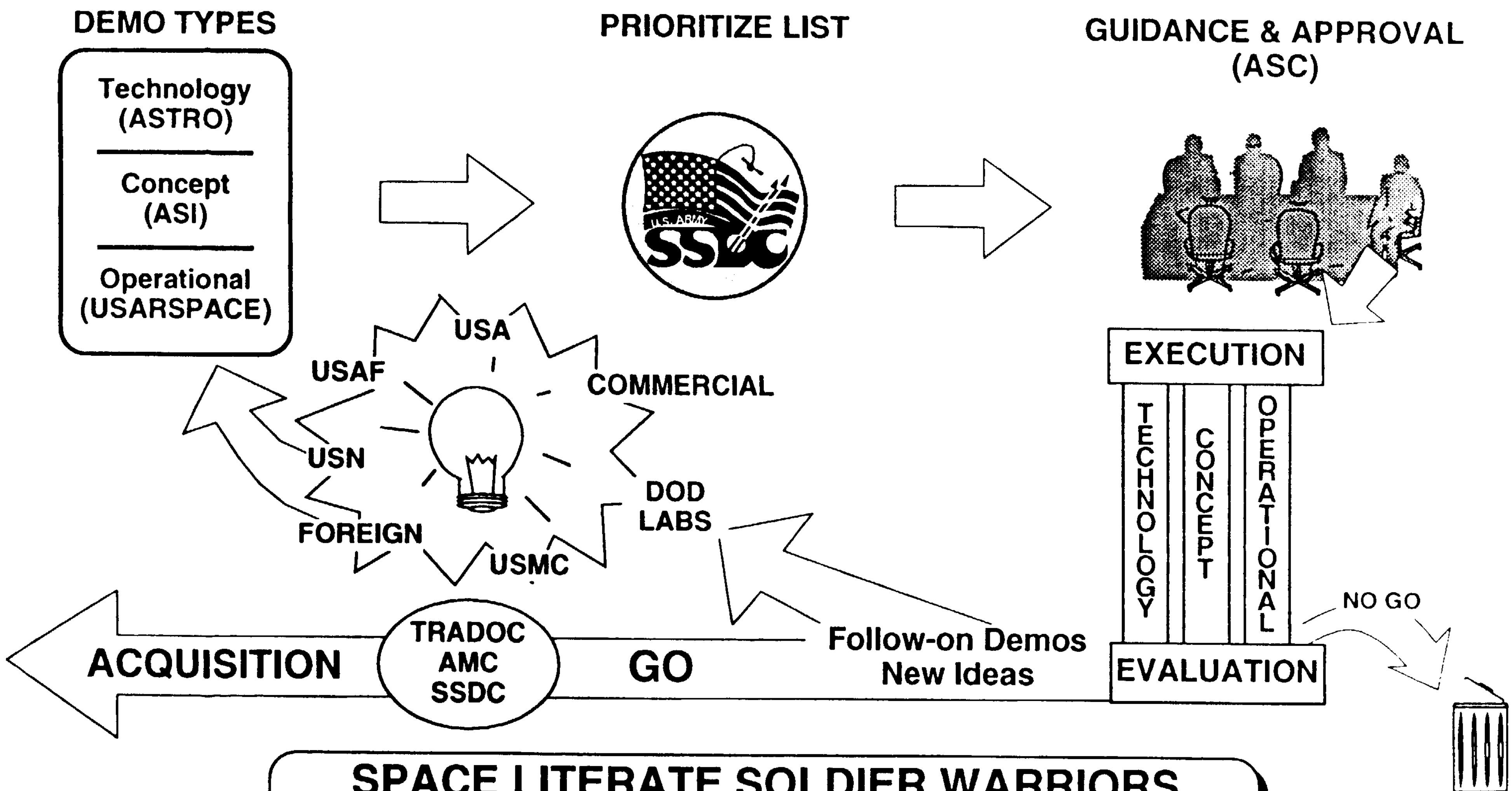
ARMY SPACE EXPLOITATION AND DEMONSTRATION PROGRAM



- ☑ Examining/Developing Potential Solutions For Army Space Issues
- ☑ Object Is Not To Just End Up With A Bunch Of Prototypes...Want To End Up With Things That Are Part Of The Army's Toolbox
- ☑ Do Within Context Of Army Rules And Regulations

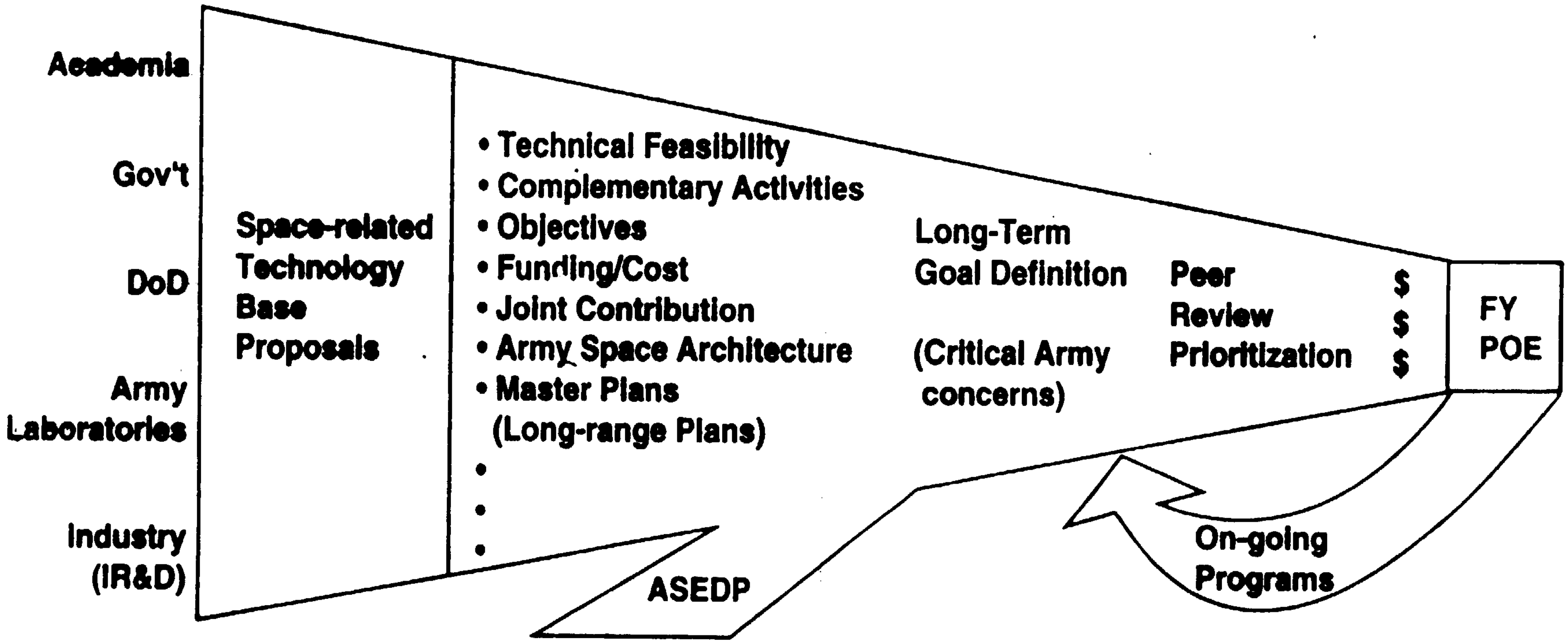
SUPPORTING THE SOLDIER WITH TOOLS HE CAN USE

ARMY SPACE DEMONSTRATION PROCEDURE



SPACE LITERATE SOLDIER WARRIORS BEST DEFINE ARMY SPACE APPLICATIONS

POE DEVELOPMENT PROCESS



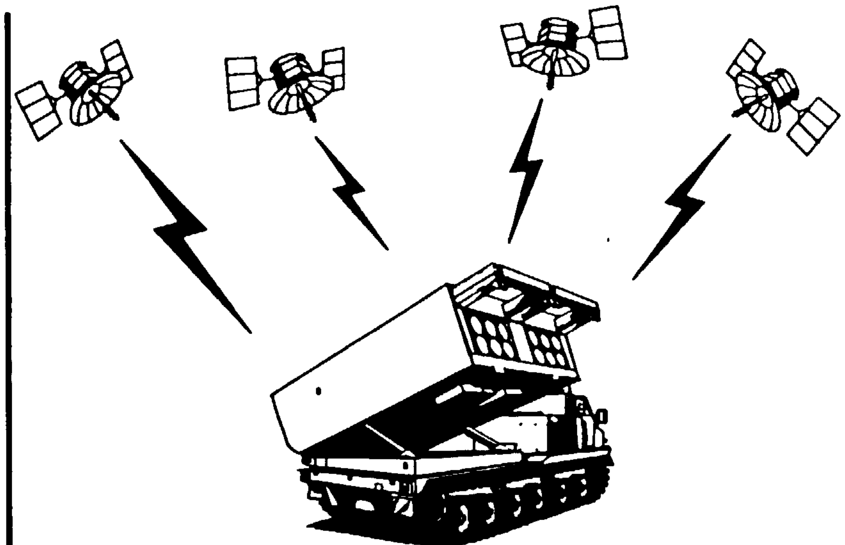
GRAPHICS
L.ASTRO. POE

GPS AZIMUTH DETERMINING SYSTEM

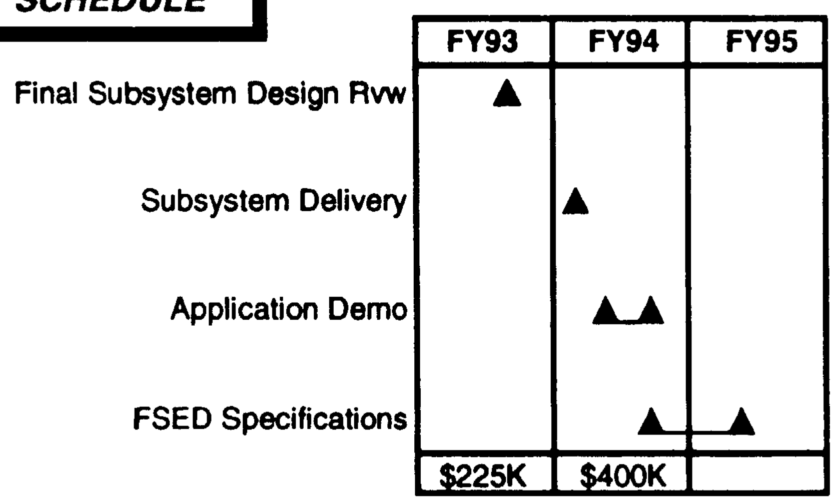
(TECHNICAL DEMONSTRATION)

OBJECTIVES

- Demonstrate Ability To Instantaneously Derive Survey-Quality Azimuth (< 1 Mile) From GPS Signal Using Less Than 1 Meter Baseline
- Transition Technology ToPM MLRS, PM TRAILBLAZER, PM AFAS.....



SCHEDULE



APPROACH AND APPLICATION

- Enhance GPS Receiver To Provide Instantaneous Survey-Quality Azimuth
- Demonstrate/Evaluate System On Selected Tactical Systems, i.e. MLRS, TRAILBLAZER, AFAS (Testbed)
- Transition To Selected PM's

- Reduced Force Structure For Artillery Batteries
- Increased Fire Rate
- Reduced Ammo Resupply

TRANSITION PARTNER(s)

USACE, PM MLRS, PM TRAILBLAZER, PM AFAS...

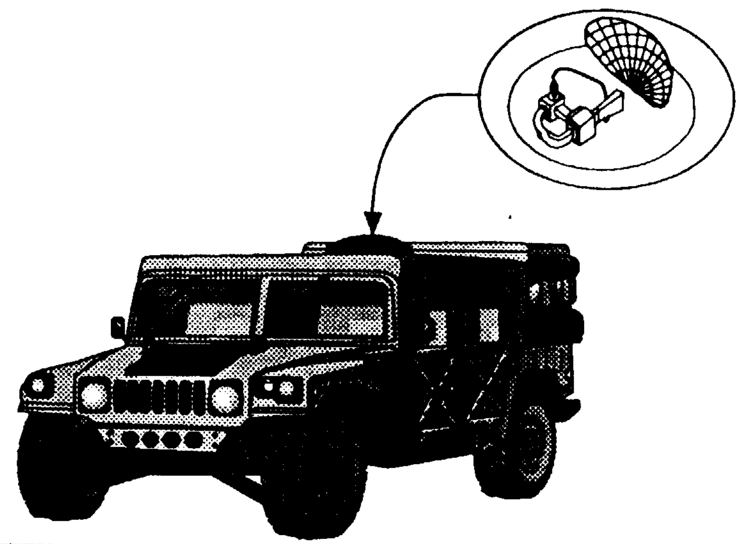
ASTRO QUAD CHTS - 01

SATELLITE COMMUNICATIONS ON THE MOVE

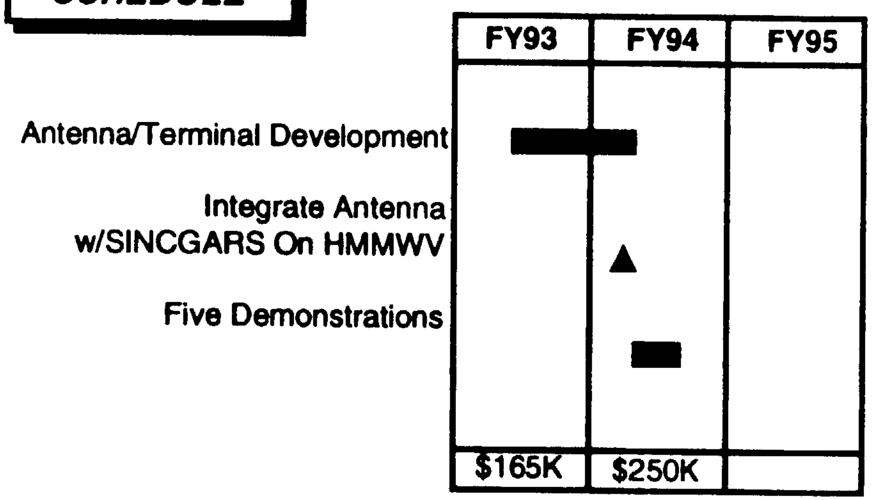
(TECHNICAL DEMONSTRATION)

OBJECTIVES

- Demonstrate Ability To Communicate From A Moving Vehicle Via EHF, High Data Rate Satellite
- Provide Data To Help Define Army Mobile SATCOM Requirements And Applications



SCHEDULE



APPROACH AND APPLICATION

- Utilize JPL's Mechanically-steered Antenna, Funded By NCS
- Integrate Antenna With A Sincgars Radio Installed On A HMMWV, Donated By SIGCENTER
- Demonstrate EHF SATCOM On The Move With Battle Command Battle Lab
- Provide Data/Experience/Feedback To Global Grid Initiative

- Mobile Satellite Communications (EHF)

TRANSITION PARTNER(s)

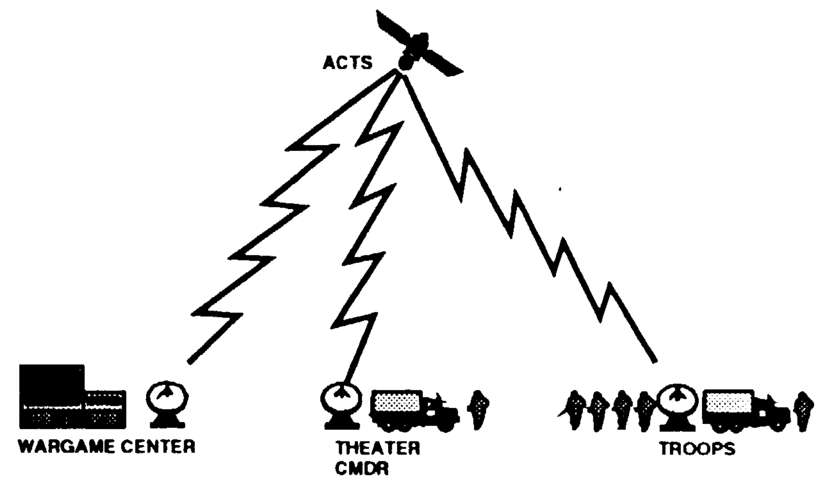
BCBL, CECOM, GLOBAL GRID

ADVANCE COMMUNICATIONS TECHNOLOGY SATELLITE (ACTS)

(OPERATIONAL DEMONSTRATION)

OBJECTIVES

- Demonstrate Secure Point-to-multipoint Video Capability Using High Data Rate EHF Satellite Communications Links
- Define Army SATCOM Requirements And Develop Performance Requirements To Influence SATCOM Architecture Studies



SCHEDULE

	FY93	FY94	FY95
Purchase Video Equipment		▲	
Interface Video Equipment w/ ACTS Terminal		▲	
Technical Demos		▲	
Operational Demos		▲	
		$300K	

APPROACH AND APPLICATION

- Acquire High-quality, Secure Multiplex Video Equipment And Integrate With ATCTS VSAT Terminals (1.2M Dish)
- Conduct Secure Video Teleconferences Using ACTS' High Data Rate EHF Communication Satellite
- Provide Data And Feedback To Global Grid

- Secondary Image Dissemination
- Secure Teleconferencing

TRANSITION PARTNER(s)

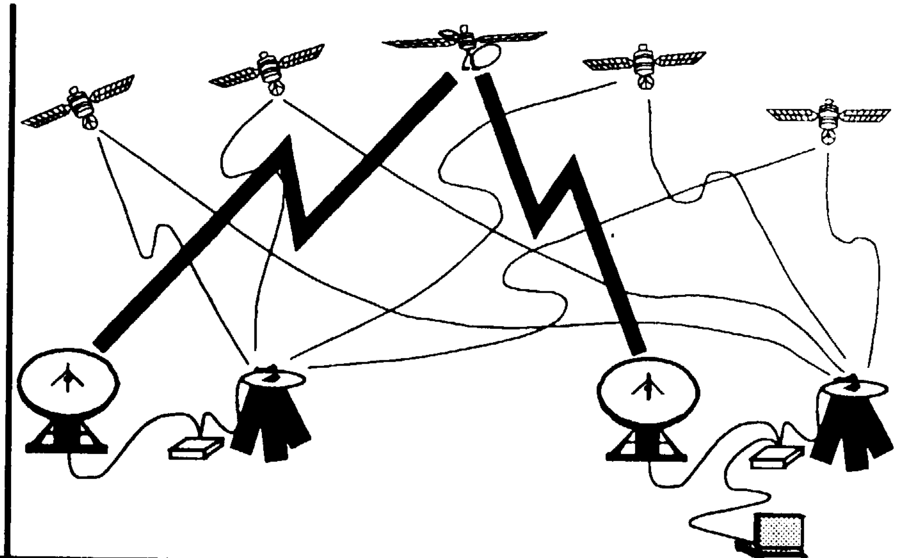
BCBL, CECOM, GLOBAL GRID

DIFFERENTIAL GPS (ACTS)

(TECHNICAL DEMONSTRATION)

OBJECTIVES

- Demonstrate Ability To Extend Differential GPS Applications Beyond LOS - To ~ 400KM
- Demonstrate Instantaneous Survey-Quality Positioning (<1 Meter Error), WITHOUT Survey Team



SCHEDULE

	FY93	FY94	FY95
Satellite Launch	▲		
Integrate Equipment	▲		
Experiments		▲ ▲	
Demonstration		▲	
	$64K	$100K	

APPROACH AND APPLICATION

- Calculate Corrections To GPS Signals Over First Order Survey Position
- Transmit Correction To "Unknown" Position Over 400km Baseline, Via High Data Rate, EHF ACTS Satellite

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- Precisely-surveyed Reference Points For Rapidly Moving Artillery Batteries

TRANSITION PARTNER(s)

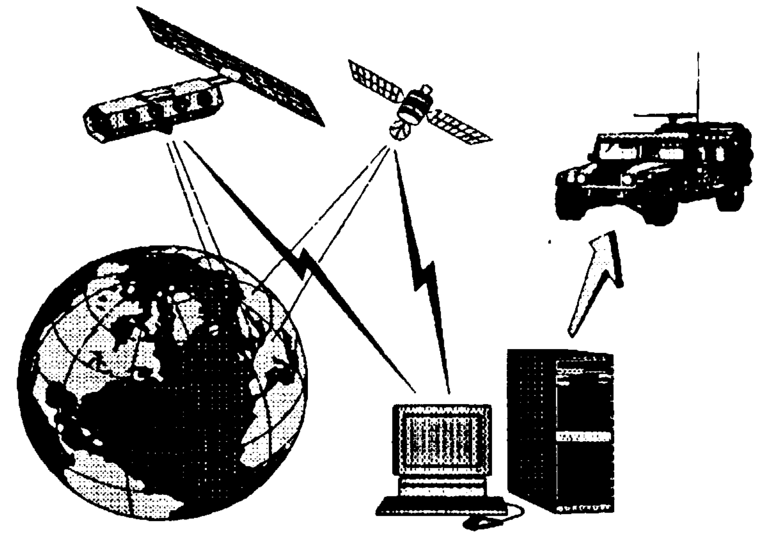
USACE, ENGR SCHOOL

DMSP EXPLOITATION

(TECHNICAL DEMONSTRATION)

OBJECTIVES

- Develop Software That Processes Raw DMSP Data To Support IPB For Deep Fire Accuracy And Deep Attack Capability
- Transition Software Module To PM EW/RSTA



SCHEDULE

	FY93	FY94	FY95
Completed Program Plan	▲		
Demo Low Res Imagery S/W		▲	
Demo Temp Profile From METSAT		▲	
Demo Visibility Estimates From Satellite Imagery Data			▲
Trans Modules To PM EW/RSTA		▲ ▲	▲
	$50K	$250K	$250K

APPROACH AND APPLICATION

- Enhance Software To Directly Receive And Process DMSP Data
- Develop Software Modules To Produce Specific Products Using ATCCS And It's Resident Algorithms
- Transition Software Modules To PM EW/RSTA

- Automated IPB Process

TRANSITION PARTNER(s)

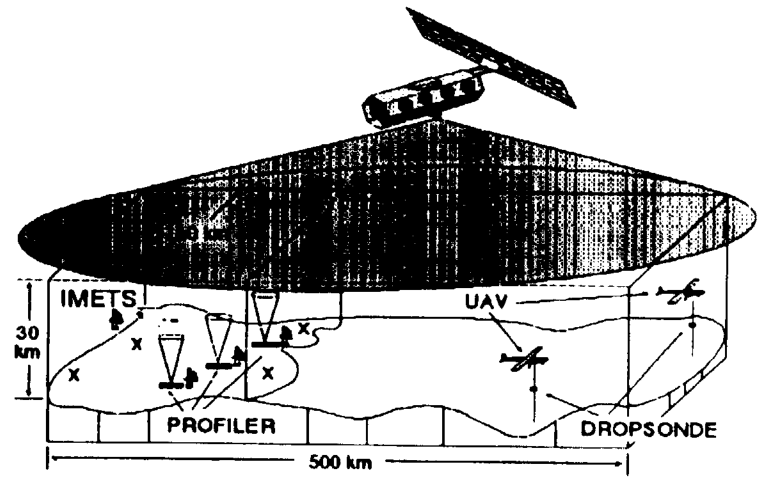
ARL/BE, PM EW/RSTA

AUTOMATED WEATHER/TERRAIN ANALYSIS

(TECHNICAL DEMONSTRATION)

OBJECTIVES

- Demonstrate Ability To Reveive And Integrate Real-Time Weather And Terrain Data Into The IPB Process In An Automated Mode
- Transition Completed Software Modules To ATCCS And IMETS



x represents Automated Metereological Sensing system (AMSS)

SCHEDULE

	FY93	FY94	FY95
Integrate S/W Into Air Defense Module	▲		
Evaluate S/W Performance		▲	
Demonstrate Capabilities In CPX With 35th ADA Bde		▲	
Transition Modules To ATCCS			▲
		Unfunded	
	$380K	$400K	$400K

APPROACH AND APPLICATION

- Establish User Interface To Receive Direct Data From Selected Sensor Platforms
- Integrate Weather And Terrain Modules For AIR IPB
- Demonstrate Enhanced Capability In CPX
- Transistion Modules To ATCCS

- Automated IPB Process

TRANSITION PARTNER(s)

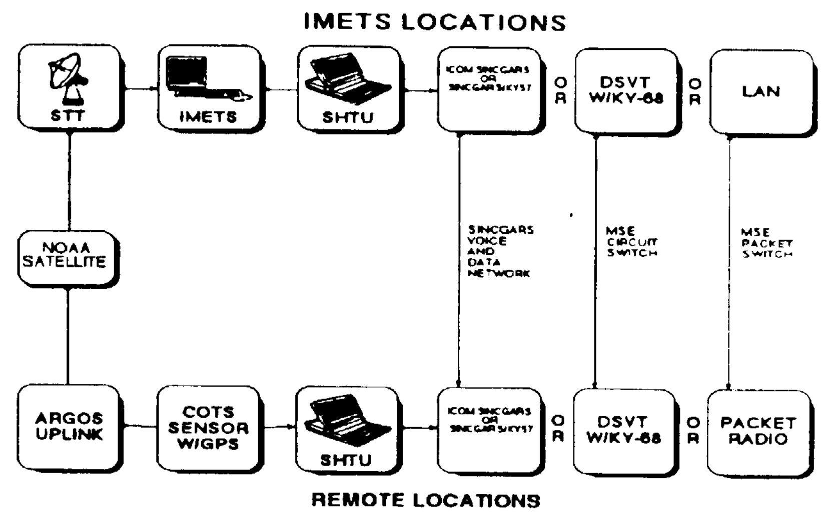
ARL/BE, 35TH ADA BDE, USACE

AUTOMATED METEOROLOGICAL SENSOR SYSTEM; COMMUNICATIONS

(TECHNICAL DEMONSTRATION)

OBJECTIVES

- Demonstrate Viable Communications Links Between AMSS Ground Sensors And The Integrated Meteorological System (IMETS)



SCHEDULE

	FY93	FY94	FY95
Procure Sensor Hardware And SATCOM Link HW/SW	▲		
Integrate S/W Mode And Conduct In-House Tests		▲	
Demonstrate Capability		▲	
Publish Results			▲

APPROACH AND APPLICATION

- Procure COTS Sensor w/GPS And ARGOS Satellite Uplink
- Evaluate Capability Of Low Power Transmitter To Pass Data To IMETS Via Common Net Radios And Area Common User System
- Evaluate Capability Of Low Power Transmitter To Pass Data To IMETS Via Polar Orbiting Satellite

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- Improved Battlefield/Target Area Weather Prediction

TRANSITION PARTNER(s)

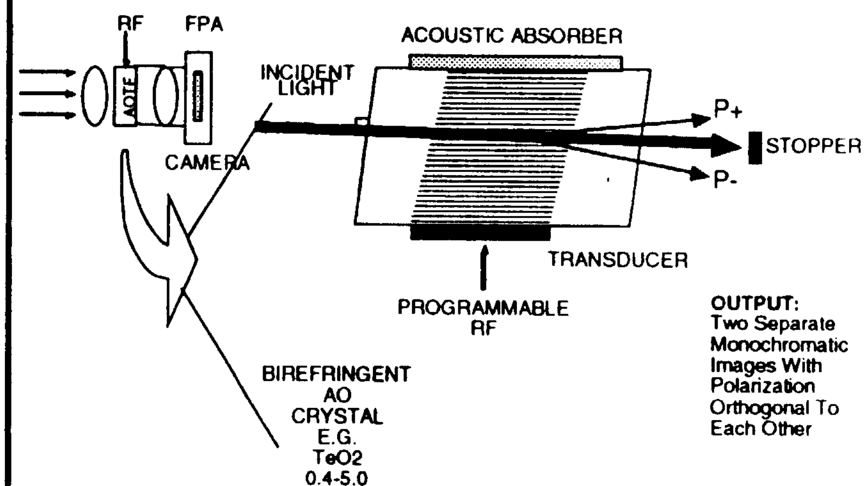
ARL/BE, PM IMETS

ACOUSTO-OPTICAL TUNABLE FILTER (AOTF) HYPERSPECTRAL IMAGING

(TECHNICAL DEMONSTRATION)

OBJECTIVES

- Demonstrate The Tactical Utility Of Using AOTF Technology To Obtain Hyperspectral Imagery
- Build, Add To, Library Of Target Signature Data
- Transition Technology To Appropriate Program Office To Integrate Into Next-Generation Satellite



SCHEDULE

	FY93	FY94	FY95
Conduct Ground-bsd Demo's	▲		
Complete Instrument Design For Airborne Collections		▲	
Integrate Instrument Onto Selected Air Platform		▲	
Conduct Airborne Data Collection And Demo's		Unfunded	▲—▲
		$785K	$900K

NOTE: Technology Transitions To Industry In FY96

APPROACH AND APPLICATION

- Develop Test Plan With USAIC Target Sets
- Build Ground-based Sensor, Collect Data And Evaluate Results
- Demonstrate Ability To Detect Hidden Targets Of Interest
- Build Airborne Sensor, Collect Data And Evaluate Results
- Transition Technology ToLANDSAT Program Office
- Use Data To Build Library Of Signature Data

- Tactical Support Imagery Data

TRANSITION PARTNER(s)

USACE, USAIC

Information on SOAR '94

Mr. Robert Savely
NASA Johnson Space Center

EXAMPLE: SOAR '94 DEVELOPMENT SCHEDULE

2/15	- MAIL SOAR ANNOUNCEMENT
4/15	- SESSION AND PAPER SELECTION DEADLINE
4/29	- AUTHORS' KITS MAILED DEADLINE
4/29	- COMPLETE PRELIMINARY PROGRAM
5/16	- MAIL PRELIMINARY PROGRAM
5/16	- SESSION CHAIRMAN SELECTION DEADLINE
6/1	- ABSTRACTS DUE
6/15	- FINAL PROGRAM UPDATES DUE
7/1	- FINAL PROGRAM PRINTED AND MAILED TO SOC SUBCOMMITTEE AND SPEAKERS
8/2,3,4	- PAPERS DUE AT TIME OF SPEAKER REGISTRATION
8/2,3,4	- CONFERENCE

"Committee decided to postpone SOAR '94 to Spring of 1995 and possibly combine with another technology conference to make it cost effective."

Dr. Kumar Krishen, Co-chairman
STIG Operations Committee

ANNOUNCEMENT

Space Technology Interdependency Group

SPACE OPERATIONS, APPLICATIONS, AND RESEARCH SYMPOSIUM

AUGUST 3–5, 1993

(Please note the change in dates for the conference)

SOAR'93 will include USAF and NASA programmatic overviews, panel sessions, exhibits, and invited technical papers, in support of U.S. Army, Navy, DOE, NASA, and USAF Programs in the following areas:

	USAF	NASA
Robotics and Telepresence	Capt. Ron Julian AL/CFBA 513 255-3671	Dr. Charles Weisbin NASA JPL 818 354-2013
Automation and Intelligent Systems	Capt. Jim Skinner WL/AAA-1 513 255-5800	Dr. Peter Friedland NASA Ames 415 604-4277
Human Factors	Col. Donald Spoon AL/CF 513 255-5227	Dr. Mary Connors NASA Ames 415 604-6114
Life Sciences	Dr. Andrew Pilmanis AL/CFTS 512 536-3545	Dr. Gerald Taylor NASA JSC 713 483-6057
Space Maintenance and Servicing		Mr. Charles Woolley NASA JSC 713 283-5362

Symposium Coordinators

Symposium Chair	Symposium Co-Chair	USAF	NASA
Dr. Kumar Krishen	Dr. W.C. Alexander	Col. John Tedor	Mr. Robert T. Savely
NASA JSC	USAF AL/XP	AL/XPT	NASA JSC
713 283-5875	512 536-2091	512 536-2661	713 483-8105

Conference Location: Gilruth Recreation Center
NASA/Johnson Space Center
Houston, Texas 77058

Co-Sponsored by: Air Force Materiel Command
NASA/Johnson Space Center

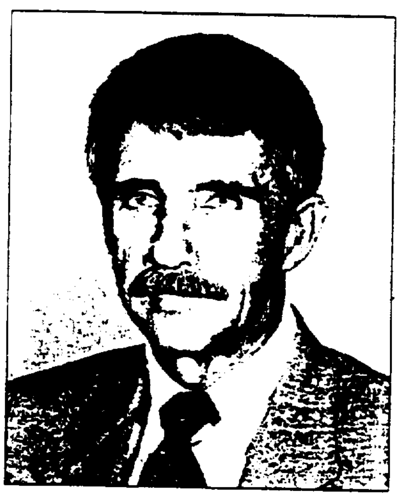
For more information on registration or exhibits, contact:

University of Houston, 713 283-3030 (registration), Chris Ortiz, 713 483-1904 (exhibits),
SOAR Conference, Gilruth Recreation Center, NASA Johnson Space Center, Houston, TX 77058

U.S. Gov't

MESSAGE

Symposium Chairman:
Dr. Kumar Krishen
NASA Johnson Space Center



Symposium Co-Chairman:
Dr. W. C. Alexander
U.S. Air Force, AL/XPT

...from the Co-Chairs

We welcome your participation in the Space Operations, Applications and Research (SOAR) '93 Symposium and Exhibition. The Primary purpose of SOAR '93 is to facilitate interchange of technical information and share lessons learned. SOAR also provides an opportunity for participants to interact with each other. This interaction is important to the development of interdependent programs between government laboratories and agencies.

SOAR '93 is developed and executed by the STIG Operations Committee (SOC). The technical areas of responsibility for SOC are: Robotics and Telepresence, Automation and Intelligent Systems, Human Factors, Life Support, and Space Maintenance and Servicing. The goals of SOC are to: (1) identify, characterize, and encourage interdependent programs (2) interchange technical and programmatic information and share lessons learned; (3) identify critical voids and non-productive overlaps in technology programs; and (4) involve industry, academia, and research institutions in the technical interchange and technology needs identification.

SOAR '93 promotes cooperation between government agencies, industry, academia, and research institutions for the development of space technology and transfer of this technology to the private sector. Through cooperative Research and Technology (R&T) and well coordinated programs, each institution/agency will benefit by leveraging of resources. This is crucial in today's economic environment. SOAR '93 provides us with opportunities for mutual goal setting, information sharing, and cooperative long range planning.

Your participation in SOAR will ensure its success and make SOAR of great benefit to our Nation. ❑

ROGRAM

'uesday, August 3, 1993

:5 am – 5:00 pm	Registration
-30 am	Welcome/Opening Address: Mr. Aaron Cohen, NASA JSC; Dr. W. C. Alexander, AL/XP; Dr. Kumar Krishen, NASA JSC
:00 am	Keynote Session – *Operations Experiences*: Flight Director, NASA JSC; Lt. Col. Roger Bisson, USAF; Dr. Howard Schneider, NASA JSC; Lt. Col. John (Jay) Beard, USAF; Kevin Chilton, NASA Astronaut
:00	Lunch
30 pm	Parallel Sessions
:30 pm	Panel Discussion – *Operations Challenges*: Dr. Kumar Krishen, Moderator; Dr. Melvin Montemerlo, NASA HQ; Gael Squibb, NASA JPL; Flight Director, NASA JSC; Maj. Kory Cornum, USAF; Capt. Jeff Love, USAF
_)0 pm – 7:00 pm	Reception – Exhibit Hall

Nednesday, August 4, 1993

:5 am – 5:00 pm	Registration
:30 am – 10:00 am	Parallel Sessions
0:00 am – 10:30 am	Break
:30 am – Noon	Parallel Sessions
_)on – 1:30 pm	Lunch – Ballroom
30 pm – 3:00 pm	Parallel Sessions
:00 pm – 3:30 pm	Break
30 pm – 5:00 pm	Parallel Sessions
:00 pm – 6:00 pm	Reception – Exhibit Hall
:00 pm – 9:00 pm	Banquet. Master of Ceremonies: Mr. Aaron Cohen, NASA JSC. Keynote Speakers: Mr. Gregory Reck, NASA HQ; Dr. R. Earl Good, USAF

Thursday, August 5, 1993

:45 am – Noon	Registration
30 am – 10:00 am	Parallel Sessions
0:00 am – 10:30 am	Break
0:30 am – Noon	Parallel Sessions

Technical Area Coordinators

	USAF	NASA
Robotics and Telepresence	Capt. Ron Julian, AL/CFBA, (513) 255-3671	Dr. Charles Weisbin, NASA JPL, (818) 354-2013
Automation and Intelligent Systems	Capt. Jim Skinner, WL/AAA-1, (513) 255-5800	Dr. Peter Friedland, NASA ARC, (415) 604-4277
Human Factors	Col. Donald Spoon, AL/CF, (513) 255-5227	Dr. Mary Connors, NASA ARC, (415) 604-6114
Life Sciences	Dr. Andrew Pilmanis, AL/CFTS, (512) 536-3545	Dr. Gerald Taylor, NASA JSC, (713) 244-8796
Space Maintenance and Servicing		Mr. Charles Woolley, NASA JSC, (713) 244-8354

Administrative Co-Chairs:

Ms. Carla Armstrong	Barrios Technology Inc.
Ms. Lana Arnold	Lockheed/ESC
Mr. Dick Rogers	Lockheed/ESC
Ms. Stancie Chamberlain	University of Houston-Clear Lake

Exhibit Co-Chairs:

Mr. Chris Ortiz	NASA/JSC
Mr. Ellis Henry	I-NET, Inc.
Ms. Resa Ott	University of Houston-Clear Lake

Hospitality Room – 217 7:30 am – 5:00 pm

Technical Exhibits

Exhibit Hours:

Tuesday, August 3	8:00 am – 7:00 pm
Wednesday, August 4	8:00 am – 7:00 pm
Thursday, August 5	8:00 am – Noon

CONFERENCE REGISTRATION

Name ____________________

Affiliation ____________________

Mailing Address ____________________

____________________ Mail Code ________

City ____________ State ________ Zip ______

Telephone ____________ Fax ____________

Conference, August 3–5, 1993

For Industry and Contractors

- ❑ $160 Conference
- ❑ $75 One-Day Cost (Circle one) Tuesday Wednesday

For Government (Civil Servants and Military)

1. NASA/Johnson Space Center employees contact Jane Kremer, Human Resource Development, AH-311, at 483-2601.
2. All other government employees and students contact PACE, at (713) 283-3030.

Method of Payment

- ❑ Check payable to UHCL (Check # __________)
- ❑ Purchase Order (# __________)
- ❑ Visa
- ❑ MasterCard

#____________________ Exp. Date __________

Total Cost: $ ____________________

Cancellation

Failure to attend an activity does not constitute withdrawal. The Professional and Continuing Education Office must be notified of intent to withdraw either by phone or in writing. Conference fees are fully refundable if cancellation is received by July 29, 1993. Participant substitutions may be made at any time.

Registration Questions

Call PACE at (713) 282-3030. NASA JSC civil servants call Jane Kremer, Human Resources Development, AH-311, at (713) 483-2601.

Location of Conference
Gilruth Recreation Center
NASA Johnson Space Center
Houston, Texas 77058

Register by mail, phone, or fax to:

PACE

Professional and Continuing Education
University of Houston-Clear Lake
2700 Bay Area Boulevard, Box 354
Houston, Texas 77058-1098
Phone (713) 283-3030
FAX (713) 283-3039

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SPACE TECHNOLOGY INTERDEPENDENCY GROUP

WORKSHOP HIGHLIGHTS

Life Support
Biomedical Research and Development
Space Physiology
Medical Operations
Toxicology and Microbiology
Telemedicine
Thermal Stress

Space Maintenance and Servicing
Space Station Maintenance
Space Maintenance and Servicing

Automation and Intelligent Systems
Artificial Intelligence I
Artificial Intelligence II
Artificial Intelligence III
Artificial Intelligence IV

Human Factors
Ground Operations Teams
Enhanced Environments
Psychophysiology, Performance and Training Tools
Modeling in Support of Operations and Anthropometry
Being There: Prototype and Simulation for Design

Robotics and Telepresence
Navigation, Machine Perception and Exploration
Robotics Research Challenges: Panel Presentation
Robotics Research Challenges: Panel Discussion
Remote Interaction with Synthetic Environments
Remote Interaction with Physical Systems
Manipulators and End Effectors
Robotic Operations: Space and Terrestrial

HOTEL ACCOMMODATIONS

HOLIDAY INN - NASA (2)
1300 NASA Rd. 1
Houston, TX 77058
(713) 333-9167
Rate: $78.00

MOTEL 6 (1)
1001 West NASA Rd. 1
Webster, TX 77598
(713) 332-4581
Rate: $30.95 (single)
$36.95 (double)

NASA INN (7)
889 West Bay Area Blvd.
Webster, TX 77598
(713) 338-1526
Rate: $53.95 (single)
$59.95 (double)

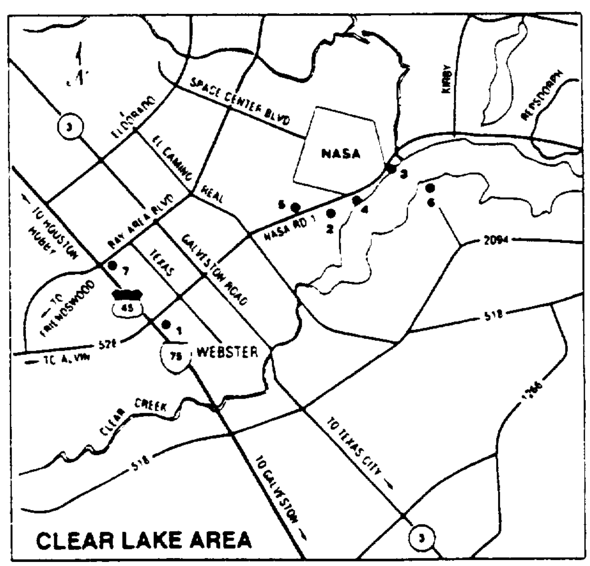
AMERICAN HOST (4)
2020 NASA Rd. 1
Houston, TX 77058
(713) 332-3551
Rate: $59.00 (single)
$64.00 (double)

NASSAU BAY HILTON (3)
300 NASA Rd. 1
Houston, TX 77058
(713) 333-9300
Gov. Rate: $78.00
Corp. Rate: $99.00 (single)

SOUTH SHORE HARBOUR RESORT AND CONFERENCE CENTER (6)
2500 South Shore Blvd.
League City, TX 77573
(713) 334-1000
Gov. Rate: $90.00
$10 extra per person
Corp. Rate: $99.00
$10 extra per person

RAMADA KINGS INN (5)
1301 NASA Rd. 1
Houston, TX 77058
(713) 488-0220
Rate: $73.00

Rates subject to change



A hospitality room will be provided in Room 217/Gilruth Center for the attendees to relax and socialize.

A message center will be available to leave messages for the attendees.

Telephone number: (713) 483-0318.

Tuesday	8:00 a.m. – 4:00 p.m.
Wednesday	8:00 a.m. – 4:00 p.m.
Thursday	8:00 a.m. – 12 noon

SPACE TECHNOLOGY INTERDEPENDENCY GROUP

S O A R • 9 3

Seventh Annual

SPACE OPERATIONS, APPLICATIONS AND RESEARCH SYMPOSIUM

August 3–5, 1993

Gilruth Recreation Center
NASA Johnson Space Center
Houston, Texas

Keynote Dinner Program

Welcome and Opening Remarks	**Mr. Aaron Cohen** Director NASA Johnson Space Center
Keynote Addresses	**Mr. Gregory Reck,** NASA Headquarters **Dr. R. Earl Good**, United States Air Force
Co-Sponsored by	NASA/Johnson Space Center Air Force Materiel Command

SOAR '93 will include USAF and NASA programmatic overviews, panel sessions, exhibits, and technical papers in the following areas:

- Robotics and Telepresence
- Automation and Intelligent Systems
- Space Maintenance and Servicing
- Human Factors
- Life Sciences

Exhibit Hours

Tuesday, August 3 10:00 am – 7:00 pm
Wednesday, August 4 8:00 am – 7:00 pm
Thursday, August 5 8:00 am – Noon

Welcome/Opening Addresses (August 3, 8:30 am–9:00 am)

Mr. Aaron Cohen, NASA JSC
Dr. W. C. Alexander, AL/XP
Dr. Kumar Krishen, NASA JSC

Plenary Session (August 3, 9:00 am)

Operations Experiences

Mr. John Muratore, NASA JSC
Lr. Col. Roger Bisson, USAF
Dr. Howard Schneider, NASA JSC
Lt. Col. John (Jay) Beard, USAF
Mr. Kevin Chilton, NASA Astronaut

Panel Discussion (August 3, 3:30 pm – 5:00 pm)

Operations Challenges

Moderator: Dr. Kumar Krishen

Panelists: Dr. Melvin Montemerlo, NASA HQ
Gael Squibb, NASA JPL
Flight Director, NASA JSC
Maj. Kory Cornum, USAF
Capt. Jeff Love, USAF

Keynote Dinner Session (August 4, 6:00 pm – 9:00 pm)

Welcome and Opening Remarks: Mr. Aaron Cohen
Director
NASA JSC

Keynote Speakers: Mr. Gregory Reck, NASA HQ
Dr. R. Earl Good, USAF

Symposium Coordinators

Symposium Co-Chairs:
- Dr. Kuman Krishen
  NASA/JSC
- Dr. W. C. Alexander
  U.S. Air Force AL/XP

Technical Coordinators:
- Mr. Robert Savely
  NASA/JSC
- 2LT Catherine Moore
  AL/XPT

Administrative Co-Chairs:
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  I-NET, Inc.
- Ms. Lana Arnold
  Lockheed/ESC
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- Ms. Resa Ott
  University of Houston-Clear Lake

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Robotics and Telepresence	Capt. Ron Julian AL/CFBA (513) 255-3671	Dr. Charles Weisbin NASA JPL (818) 354-2013
Automation and Intelligent Systems	Capt. Jim Skinner WL AAA-1 (513) 255-5800	Dr. Peter Friedland NASA ARC (415) 604-4277
Human Factors	Col. Donald Spoon AL/CF (513) 255-5227	Dr. Mary Connors NASA ARC (415) 604-6114
Life Support	Dr. Andrew Pilmanis AL/CFTS (512) 536-3545	Dr. Gerald Taylor NASA JSC (713) 244-8796
Space Maintenance and Servicing		Mr. Charles Woolley NASA JSC (713) 244-8354

SOAR'93 WEEK AT A GLANCE

	7:30	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30	1:0(
			Registration – Gilruth Center Lobby – 7:30 ᶏ									
TUESDAY **August 3** • Opening Address • Parallel Sessions • Panel • Reception	Welcome – Opening Addresses Mr. Aaron Cohen Dr. W. C. Alexander Dr. Kumar Krishen			Plenary Session: *Operations Experiences* Ballroom ● Robotics and Telepresence ● Automation and Intelligent Systems ● Space Maintenance and Servicing ● Human Factors ● Life Sciences						Lunch 12:00 – 1:30 Ballroom		
WEDNESDAY **August 4** • Parallel Sessions • Reception • Keynote			A1 Artificial Intelligence I — Ballroom R2 Robotics & Telepresence Research Challenges: Panel Presentations — Rm 204 H2 Enhanced Environments — Rm 206 L2 Medical Operations — Rm 217			Break	A1 Artificial Intelligence I *(continued)* — Ballroom R3 Robotics & Telepresence Research Challenges: Panel Discussion — Rm 204 H3 Psychophysiology, Performance and Training Tools — Rm 206 L3 Telemedicine — Rm 217					
THURSDAY **August 5** • Parallel Sessions • Tutorials			A3 Artificial Intelligence III — Ballroom R6 Manipulators and End Effectors — Rm 204 S1 Space Station Maintenance — Rm 206			Break	A4 Artificial Intelligence IV — Ballroom L6 Toxicology and Microbiology — Rm 217 R7 Robotics Operations: Space Terrestrial — Rm 204 S2 Space Maintenance and Servicing — Rm 206					

2:00	2:30	3:00	3:30	4:00	4:30	5:00	5:30	6:00	6:30	7:00	7:30	8:00	8:30	9:00	9:30
00 pm															
Navigation, Machine 'erception & xploration Rm 204		Break	Panel Discussion: *Operations Challenges* Dr. Kumar Krishen Dr. Melvin Montemerlo Mr. Gael Squibb Mr. John Muratore Maj. Kory Cornum Ballroom			Reception Exhibit Hall									
́round Operations eams Rm 206		Break													
'pace Physiology Rm 217		Break													
Artificial Intelligence II Ballroom		Break	R5 Remote Interaction with Physical Systems Rm 204			Cocktails Exhibit Hall		Keynote Session Master of Ceremonies Mr. Aaron Cohen, NASA JSC Keynote Speakers: Mr. Gregory Reck, NASA HQ Dr. R. Earl Good, USAF							
̀emote Interaction vith Synthetic Environments Rm 204		Break	H5 Being There: Prototype and Simulation for Design Rm 206												
ıodelling in Support of Operations and Anthropometry Rm 206		Break	L5 Biomedical Research and Development Rm 217												
Thermal Stress Rm 217		Break													

Legend:
- R – Robotics and Telepresence
- A – Automation and Intelligent Systems
- S – Space Maintenance and Servicing
- H – Human Factors
- L – Life Sciences

TUESDAY, August 3, 1993
1:30 - 3:30 p.m.

R1 Navigation, Machine Perception & Exploration
Session Chair: Dr. Brian Wilcox

- *Microrover Research at JPL*
  Dr. Brian Wilcox
- *Design of the MESUR Pathfinder Microrover*
  Dr. Henry Stone
- *Air Force Construction Automation/Robotics*
  Mr. Al Nease
- *Lunar Exploration Rover Program Developments*
  Dr. Paul Klarer

H1 Ground Operations Teams
Session Chair: Dr. Kristin Bruno

- *The Role of Human Factors Engineering Evaluations in the Safety Review of Advanced Nuclear Power Plants*
  Dr. John O'Hara
- *Using Task Analysis to Understand the Data Systems Operations Team (DSOT)*
  Ms. Barbara Holder
- *Computer Supported Cooperative Work for NASA Ground Systems*
  Mr. Mike Moore
- *Mission Operations and Command Assurance: Flight Operations Quality Improvements*
  Ms. Linda Welz

L1 Space Physiology
Session Chair: Ms. Susan Fortney

- *Gravity, the Third Dimension of Life Support in Space*
  Dr. Russell Burton
- *The US Navy/Canadian DCIEM Research Initiative on Pressure Breathing Physiology*
  Phillip Whitley
- *Response to Graded Lower Body Negative Pressure (LBNP) after Space Flight*
  Susan Fortney
- *Selected Physiological Responses to Combined Arm and Leg Exercise Proposed to Increase EVA Prebreathe Effectiveness*
  Christine Heaps
- *Excercise with Prebreathe Increases Protection from Decompression Sickness*
  J.T. Webb
- *Orthasiatic Responses to Dietary Sodium Restriction During Heat Acclimation*
  P.C. Szlyk

TUESDAY, August 3, 1993
3:30 - 5:00 p.m.

Panel Discussion – *Operations Challenges*
Dr. Kumar Krishen, Moderator
Dr. Melvin Montemerlo, NASA HQ
Mr. Gael Squibb, NASA JPL
Mr. John Muratore, NASA JSC
Maj. Kory Cornum, USAF

5:00 - 7:00 p.m.
RECEPTION IN EXHIBIT HALL

WEDNESDAY, August 4, 1993
8:30 - 10:00 a.m.

A1 Artificial Intelligence I
Session Chair: Dr. Peter Friedland

- *The Importance to NASA of University Collaborative Research*
  Mr. Mel Montemerlo
- *AFOSR AI Research Thrust*
  Dr. Abe Waksman
- *The Stanford How Things Work Project*
  Dr. Richard Fikes
- *Real-Time Reasoning Meets Real-Time Perception*
  Dr. Stan Rosenschein
- *From Numerical Probabilities to Qualitative Reasoning*
  Judea Pearl

R2: Robotics & Telepresence Research Challenges: Panel Presentations
Session Chair: Capt. Paul Whalen

Panel Members:
Dr. Chuck Weisbin, NASA JPL
Mr. Chuck Shoemaker, U.S. Army (ARL)
Dr. Harold Hawkins, U.S. Navy (ONR)
Maj. Michael B. Leahy, Jr., U.S. Air Force (SA-ALC/TEST)
Mr. Joe Herndon, U.S. Dept. of Energy (ORNL)
Mr. Charlie Price, NASA JSC

H2 Enhanced Environments
Session Chair: Maj. Gerald Gleason

- *Call Sign Intellibility Improvement Using a Spatial Auditory Display: Application to KSC Speech Communications*
  Dr. Durand Begault
- *Laboratory and In-Flight Experiments to Evaluate the Efficacy of 3-D Audio Display Technology*
  Mr. Mark Ericson
- *Fusion Interfaces for Tactile Environments: An Approach for Applying Virtual Reality Technology*
  Mr. Michael Haas
- *Virtual Reality as a Human Factors Design Analysis Tool: Macro-Ergonomic Application Validation and Assessment of the Space Station Freedom Payload Control Area*
  Mr. Joseph Hale
- *Using Virtual Reality as a Task Analysis Tool for Space Missions*
  Dr. Abhilash Pandya

L2 Medical Operations
Session Chair: Lt. Col. Roger Bisson

- *A Concept for Telepresence Surgery*
  P. McCormack
- *Total Hydrocarbon Analysis by Ion Mobility Spectrometry*
  Mr. John Cross
- *Effectiveness of Ground Level Oxygen Treatment for Altitude-Induced Decompression Sickness*
  J.T. Demboski
- *Emergency Medical Services*
  Dr. Roger Billica
- *Preliminary Health Survey Results from Over 2! High Flyer Pilots with Occupational Exposures t Altitudes Over 60,000 Feet*
  Lt. Col. Roger Bisson

WEDNESDAY, August 4, 1993
10:30 - Noon

A1 Artificial Intelligence I (cont'd)
Session Chair: Dr. Peter Friedland

- *Combined Analytic and Inductive Approach to Learning*
  Michael Pazzani
- *Speedup Learning in Scheduling*
  Thomas Dietterich
- *Constraint-Directed Integration of Scheduling a Planning for Space-Based Observatory Management*
  Mr. Stephen Smith

R3 Robotics & Telepresence Research Challenges: Panel Discussion
Session: Capt. Paul Whalen

Panel Members:
Dr. Chuck Weisbin, NASA JPL
Mr. Chuck Shoemaker, U.S. Army (ARL)
Dr. Harold Hawkins, U.S. Navy (ONR)
Maj. Michael B. Leahy, Jr., U.S. Air Force (SA-ALC/TEST)
Mr. Joe Herndon, U.S. Dept of Energy (ORNL)
Mr. Charlie Price, NASA JSC

H3 Psychophysiology, Performance and Training Tools
Session Chair: Dr. James Whitely

- *Autogenic-Feedback Training Improves Pilot Performance During Emergency Flying Conditions*
  Dr. Patricia Cowings
- *Implementing Bright Light Treatment for MSF Payload Operations Shiftworkers*
  Ms. Benita Hayes
- *Flight Controller Alertness and Performance During MOD Shiftwork Operations*
  Dr. Mark Rosekind
- *Automating the Training Development Process for Mission Flight Operations*
  Ms. Carol Scott

L3 Telemedicine
Session Chair: Dr. Gerald Taylor

- *Dynamic Quantitative 3-D Phototonic Sensir and Imaging System for Tele-medicine and Space Robotics Applications*
  Bruce Altschuler
- *MIS—An Intelligent Microscope Imaging Sy*
  Mr. Norwood Hunter

- *The Portable Dynamic Fundus Instrument: Uses in Telemedicine and Research*
  Mr. Michael Caputo
- *Technical Parameters for Specifying Imagry Requirements*
  Mr. Paul Coan

WEDNESDAY, August 4, 1993
1:30 - 3:40 p.m.

A2 Artificial Intelligence II
Session Chair: Dr. Abe Waksman

- *Learning Procedures from Interactive Natural Language Instructions*
  Mr. Scott Huffman
- *Fuzzy Logic, Neural Networks and Soft Computing*
  Dr. Lotfi Zadeh
- *Hybrid Knowledge Bases for Intelligent Reasoning*
  V.S. Subramahnian
- *Learning to Use Devices from Multiple Knowledge Sources*
  Paul Rosenbloom

Strategy Meeting

- *Induction of Operating Modes for Monitoring*
  Mr. Doug Fisher
- *Self-Calibrating Models for Dynamic Monitoring and Diagnosis*
  Benjamin Kuipers

WEDNESDAY, August 4, 1993
1:30 - 3:00 p.m.

R4 Remote Interaction with Synthetic Environments
Session Chair: Dr. Harold Hawkins

- *Shared Virtual Environments for Aerospace Training*
  Dr. R. Bowen Loftin
- *Surgery Applications of Virtual Reality*
  Dr. Joseph Rose
- *A Study of Navigation in Virtual Space*
  Mr. Randy Shumaker
- *Robolab and Virtual Environments*
  Mr. Joseph Giarratano

H4 Modelling in Support of Operations and Anthropometry
Session Chair: Ms. Barbara Woolford

- *Application of Statistical Process Control and Process Capability Analysis Procedures at the Kennedy Space Center*
  Mr. Timothy Barth
- *Task Network Models in the Prediction of Workload Imposed by Extravehicular Activities During the Hubble Space Telescope Servicing Mission*
  Mr. Manual Diaz
- *Tools for Automated Knowledge Engineering (TAKE)*
  Capt. Marie Gomes

- *An Overview of Space Shuttle Anthropometry and Biomechanics Research with Emphasis on STS/MIR Recumbant Seat System Design*
  Mr. Glenn Klute
- *Anthropometric Accomodation in USAF Cockpits*
  Mr. Gregory Zehner

L4 Thermal Stress
Session Chair: Col. Jerry Kruger

- *Personal Cooling Systems: Possibilities and Limitations*
  Ms. Sarah Nunneley
- *Modeling Heat Exchange Characteristics of Long Term Space Operations: Role of Skin Wettedness and Exercise*
  Richard Gonzales
- *Hydration and Blood Volume on Human Thermoregulation in the Heat: Space Applications*
  Mr. Michael Sawka
- *Prediction Modeling of Physiological Responses and Human Performance in the Heat with Application to Space Operations*
  Kent Pandolf
- *Advances in USN Cold Water Immersion Protection*
  Ms. Colleen Browne

WEDNESDAY, August 4, 1993
3:30 - 5:00 p.m.

R5 Remote Interaction with Physical Systems
Session Chair: Mr. Joe Herndon

- *Development and Demonstration of a Telerobotic Excavation System*
  Mr. B.L. Burks
- *A Teleoperated System for Remote Site Characterization*
  Dr. Gerald Sanoness
- *Vehicle Development for Lunar/Mars Exploration*
  Dr. James Purvis
- *Omniview & Telepresence: Compensating for Time Delayed Video and Video-Based Position Control & Collision Avoidance*
  Mr. Steve Zimmerman and Mr. Dan Kuban

H5 Being There: Prototype and Simulation for Design
Session Chair: Dr. Jane Malin

- *End-Effector Monitoring System: An Illustrated Case of Operational Prototyping*
  Dr. Jane Malin
- *The Plaid Graphics Analysis Impact on the Space Program*
  Ms. Jennifer Nguyen
- *Human Factors Involvement in Expert System Design for the End User: COMPAQ's QuickSolve*
  Ms. Mary Czerwinski
- *A Comparison of Paper and Computer Procedures in a Shuttle Flight Environment*
  Mr. Michael O'Neal

L5 Biomedical Research and Development
Session Chair: Capt. Terrell Scoggins

- *Evaluation of a Liquid Cooling Garment as a Component of the Launch and Entry Suit (LES)*
  Mr. James Waligora
- *La Chalupa-30: Lessons Learned from a 30-day Subsea Mission Analogue*
  Mr. Steve Vander Ark
- *An Improved Anti-G Suit for Space Shuttle Reentry*
  Mr. John Marshall
- *Current and Future Issues in USAF Full Pressure Suit Research and Development*
  Capt. Terrell Scoggins
- *Advanced Integrated Life Support System Update*
  Phillip Whitley

5:00 - 6:00 p.m. Cocktails

6:00 - 9:00 p.m. Banquet

Master of Ceremonies:
Mr. Aaron Cohen, NASA JSC

Keynote Speakers:
Mr. Gregory Reck, NASA HQ
Dr. R. Earl Good, USAF

THURSDAY, August 5, 1993
8:30 - 10:00 a.m.

A3 Artificial Intelligence III
Session Chair: Dr. Peter Friedland

- *Control Reasoning in Dynamic Environments*
  Martha Pollack
- *Translation into Less Expressive Languages*
  Mr. Jeffrey Van Baalen
- *Using Machine Learning to Generate Self-Customizing Forms*
  Mr. Jeffrey Schlimmer
- *Automated Knowledge-Base Refinement*
  Mr. Raymond Mooney
- *Developing Large Multi-Purpose Knowledge Bases*
  Mr. Bruce Porter
- *Recursive Heuristic Classification*
  Mr. David Wilkins

R6 Manipulators and End Effectors
Session Chair: Mr. Charlie Price

- *Dexterous End Effector Flight Demonstration*
  Mr. Leo Monford
- *Undersea Applications of Dexterous Robotics*
  Mr. Mark Gittleman
- *Robotic Technologies of the Flight Telerobotic Servicer Including Fault Tolerance*
  Mr. John Chladek
- *EVA Scram Operations*
  Mr. David Tamir

S1 Space Station Maintenance
Session Chair: Mr. Kevin Watson

- *Unique Methods for On-Orbit Structural Repair, Maintenance and Assembly*
  Mr. Ray Anderson
- *On-Orbit NDE—A Novel Approach to Tube Weld Inspection*
  Mr. Kerry Michaels
- *Force Override Rate Control for Robotic Manipulators*
  Dr. Morris Driels
- *NASA Shuttle Logistics Depot Support to Space Station Logistics*
  Mr. Richard McMillan

THURSDAY, August 5, 1993
10:30 a.m. - Noon

A4 Artificial Intelligence IV
Session Chair: Dr. Abe Waksman

- *Agent Oriented Programming*
  Mr. Yoav Shoham
- *The Astronaut Science Advisor on SLS-2*
  Lyman Hazelton
- *Design Knowledge Recycling: In Near Real Time*
  Mr. Larry Leifer
- *A Toolbox for Scientific Model Development*
  Mr. Thomas Ellman

L6 Toxicology and Microbiology
Session Chair: Mr. Richard Sauer

- *Continuous Monitoring of Bacterial Attachment*
  Mr. David Koenig
- *Characterization of Spacecraft Humidity Condensate*
  Ms. Susan Muckle
- *Computation of Iodine Species Concentrates in Water*
  Mr. John Schultz
- *A Volatile Organic Analyzer for Space Station: Description and Evaluation of a Gas Chromatography/Ion Mobility Spectrometer*
  Mr. Thomas Limero
- *Safety Concerns for First Entry Operations of Orbiting Spacecraft*
  Mr. Steve Wilson

R7 Robotic Operations: Space Terrestrial
Session Chair: Mr. Charles Shoemaker

- *Ground Vehicle Control at NIST: from Teleoperation to Autonomous*
  Mr. Karl Murphy
- *Intelligent Vehicle Control: Opportunities for Terrestrial-Space System Integration*
  Mr. Charles Shoemaker
- *The Servicing Aid Tool: A Teleoperated Robotics System for Space Applications*
  Mr. Keith Dorman
- *Robotic Vehicle Mobility and Task Performance — A Flexible Control Modality for Manned Systems*
  Dr. Frederick Eldredge

S2 Space Maintenance and Servicing
Session Chair: Mr. Charles Woolley

- *A Systems Approach for Telerobotic Servicing of Space Assets*
  Mr. James Pinkerton
- *Diagnosing Anomalies of Spacecraft for Maintenance and Servicing*
  Mr. Mark Rolincik
- *The Scram Tool-Kit*
  Mr. David Tamir
- *Spacehab 1 Maintenance Experiments*
  Mr. Jackie Bohanon

S O A R • 9 3

NASA Operations Technology Development
A New Approach

Dr. Melvin Montemerlo
NASA Headquarters

OPERATIONS TECHNOLOGY PROGRAM

SPACE AND PLANETARY

DELIVERABLES AND BENEFITS

FY'94

- Planetary satellite navigation control software development tool.
  - increase number of requests NAIF team generates by factor of 25.
- Automatically classify all objects in Palomar Northern Sky Survey images
  - Reduce object cataloging time from years to days.
  - Enable first-ever generation of complete catalogues
- Automated intelligent perfomance monitoring tools for Galileo(Sharp/Marvel).
  - Saves at least $750,000 in MO&DA costs.
- Automated scheduling system for Deep Space Network 26 meter subnet.
  - Schedules twice the number of passes, and reduces workload by 30%.
- Multi-Media user interface for Planetary Data System
  - Increase accessability of science data to scientists, students, teachers.

FY'95

- Multi-link control system and real-time scheduler for DSN Station upgrade.
  - Reduces number of operators from many to one for multiple links.
  - Reduce set-up time & operations cost. Increase antenna availability.
- Trainable image analysis system with class discovery capability for sky survey.
  - Decrease time and cost by >90% for analysis and cataloging of terabyte image databases with greater than human accuracy.
- Deliver fully capable payload and platform operations system for Explorer-class mission to UC Berkeley EUVE project.
  - Enables "extended" mission and science operations from Universities.
  - Enables up to $7M MO&DA cost reduction for EUVE project per year.
- Complete interactive graphical scientific modelling tool for planetary atmospheric science (Sigma-Keller).
  - Reduce time to do math model of atmospheric phenomena by 75%.

FY'96

- Automated planetary image data preparation and processing (VICAR system).
  - Reduce image processing plan development time from months to days.
- Automated distributed missions operations tools for Discovery class mission.
  - Enable joint University/Center operations of Pluto Fast Fly-by.
- Automated scheduling & spacecraft performance tools to Cassini.(Muscettola).
  - Enable planned reduction in Cassini operations costs by 50% in sequencing area over current equivalent mission.
- Hyper-resolution image reconstruction system for planetary image analysis.
  - Enables 8-fold increase in multiple image resolution.

FY'97

- Automated science scheduler will uplink sequence for Discovery missions.
  - Enables integrated science and operations teams to produce multi-discipline plans, schedules, and validated command sequences.

OPERATIONS TECHNOLOGY PROGRAM

SPACE AND PLANETARY

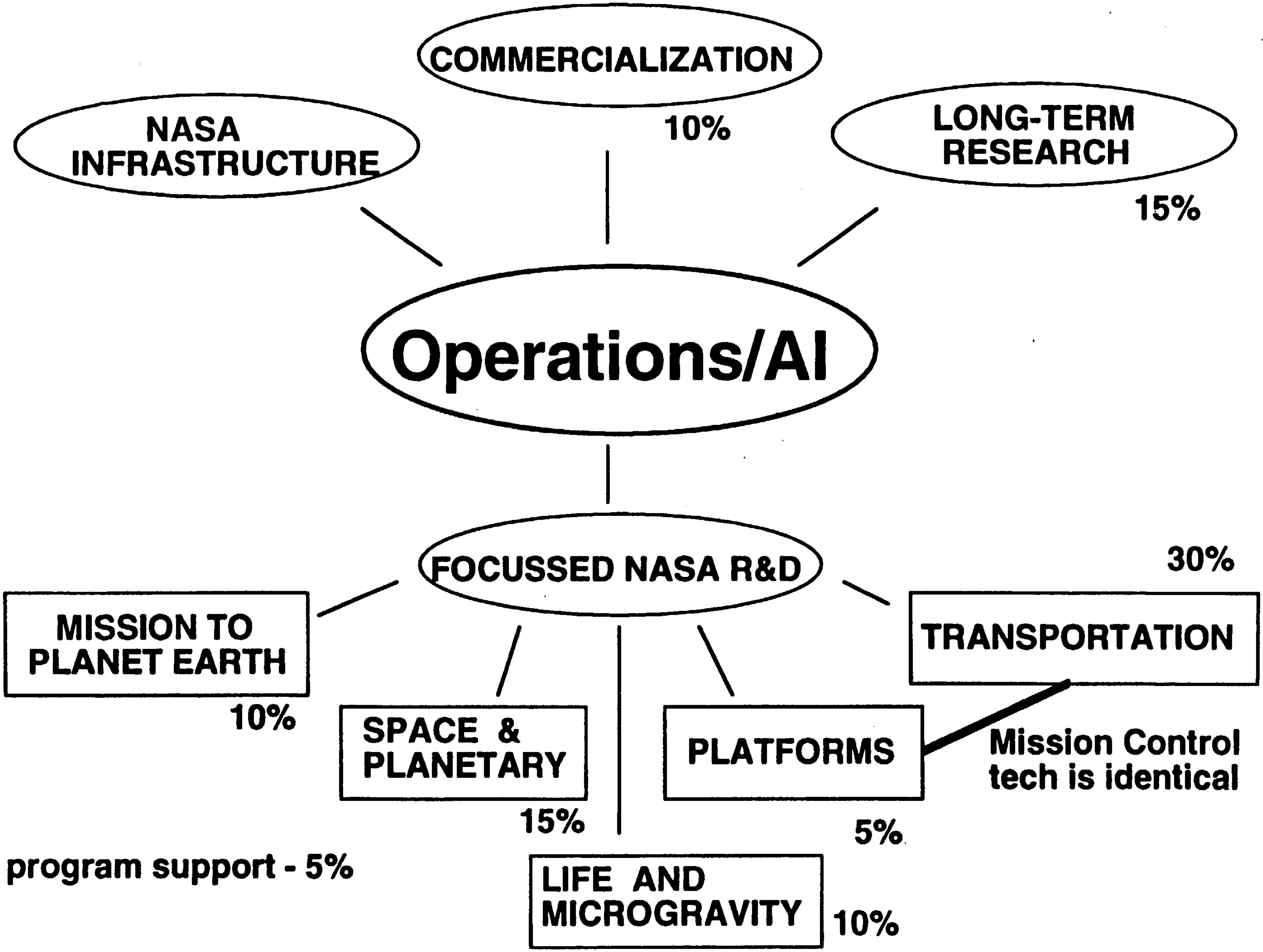
Apply intelligent automation technology to:

• **Satellite Mission Operations**	
- Uplink sequence development automation	JPL (Grenander)
- Automated Cassini instrument scheduling	ARC (Muscettola)
• **Small Satellite Operations**	
- Tech to xfer satellite mission ops to university	Berkeley/ARC/JPL
- Mission ops for Pluto Fast Flyby	JPL (Atkinson)
• **Deep Space Network Operations**	
- DSN ground operations automation	JPL (Lee)
- DSN 26 meter subnet scheduling	JPL (Biefeld)
• **Data Visualization**	
- Image classification tool	JPL (Fayyad)
- Automatically locating objects in images	JPL (Fayyad)
• **Software Engineering/Re-Use**	
- Auto. generation of orbital mechanics S/W	ARC (Lowry)
- Planetary Data System S/W reuse tool	JPL (Wong Woerner)
- Auto. image processing S/W generation	JPL (Chien)
• **Electronic Library**	
- HYLITE Hypermedia Library Technology	JPL (Wong Woerner)

OPERATIONS TECHNOLOGY PROGRAM

COMMERCIALIZATION

COMPANY	TECHNOLOGY	COMMERCIAL APPLICATION	NASA APPLICATION
AT&T	Failure prediction	telephone equipment	Shuttle, Station
General Motors	Failure prediction	automotive equipment	
Ford	Fuzzy control	electric engine control	Satellite control
AutoScope	Reactive planning	autonomous telescopes	auto. telescopes
Xerox	Reconfigurable control design	copiers	satellite control Shuttle, Station
Lockheed, Teleos, WAIS	Autonomous software agents	commercial remote sensing	EOSDIS
Honeywell	Autonomous scheduling	climate control systems	EOSDIS
Apple, Boeing, United Aircraft	Electronic documentation	aircraft maintenance	Shuttle, Station
Boeing	Virtual Reality	aircraft assembly	Astronaut Training



NASA INFRASTRUCTURE
COMMERCIALIZATION
10%
LONG-TERM RESEARCH
15%
Operations/AI
FOCUSSED NASA R&D
30%
MISSION TO PLANET EARTH
10%
SPACE & PLANETARY
15%
PLATFORMS
5%
TRANSPORTATION
Mission Control tech is identical
LIFE AND MICROGRAVITY
10%
program support - 5%

STIG ROADMAPS

...Next Step

Jerry C. Elliott
Code IA4/New Iniatives Office
NASA Johnson Space Center

STIG ROADMAPS

Chronological Developments/Milestones

DATE	ACTIVITY
October 15, 1993	Action for CO-Executive Secretaries to prode the Technical Committees with a sample roadmap for guidance
October 29, 1993	Action for Power and Propulsion Committees to produce the road maps for their areas.
November 19, 1993	Action for information, Flight Vehicles, Structures, Opoerations and Environments committees to produce road maps for respective areas.

STIG ROADMAPS

Chronological Developments/Milestones

<u>DATE</u>	<u>ACTIVITY</u>
September, 1993	STIG General Meeting Discussion of Tech Roadmaps Immediate Actions Developed. - Co-Executive Secretaries to provide sample road maps
December 10, 1993	STIG Roadmapping Video-conference
February 1, 1994	Audio teleconference to address issues with Co-Chairs
Upcoming...	
March 1, 1994	Telecon to conduct a progress review and address new issues
March 15, 1994	All roadmaps to be faxed to the Co-Executive Secretaries
March 21, 1994	Second video teleconference

STIG ROAD MAPS

Guidelines

NO STANDARD FORMATS REQUIRED
POWER COMMITTEE ROADMAP ACCEPTED GENERAL FORMAT

but...

MINIMUM REQUIRED INFORMATION ESTABLISHED:

- A descriptive name
- Sponsoring organization
- Time span and major milestones
- Dollars invested by each sponsor each year
- Relationships between individual efforts
- Program goals and, if applicable, differences in goals of participating organizations

plus...

OBJECTIVES DETAILS IN THE TECHNOLOGY AREA

MILESTONE DETAILS

DESCRIPTION OF APPROACH IN MANAGING THE INTERDEPENDENT TECHNOLOGY PROGRAMS

ROADMAP TITLE

VISION: *Statement of general capability applicable to other disciplines/areas*

OBJECTIVE: *Statement relating to utilization of a certain technology to accomplish a specific project or task.*

TECHNOLOGY AREA:

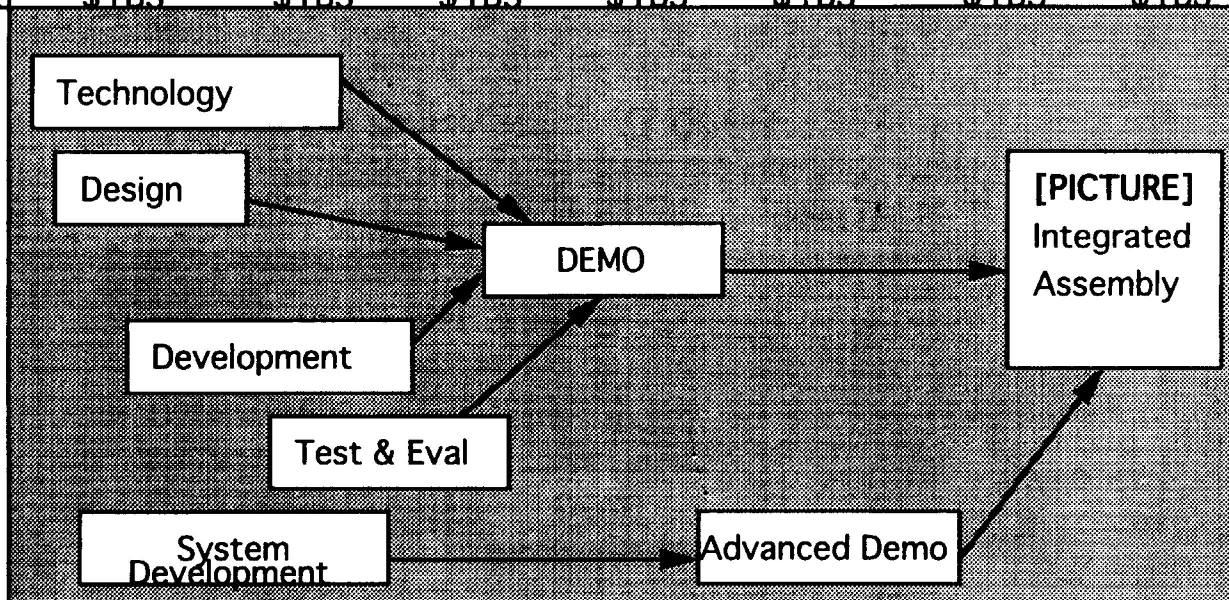
DISCIPLINE:

INVOLVEMENT

NASA	AF	ARMY	NAVY	ARPA	DOE
X	X		X		
X	X				
X					
		X			
		X	X		
			X	X	X

SAMPLE

FY94	FY95	FY96	FY97	FY98	FY99	FY00
$TBS	$TBS	$TBS	$TBS	$TBS	$TBS	$TBS



DOD Key Personnel:

AF Army Navy

Name
Address
Phone

NASA Key Personnel:

Other:

NASA CENTERS:

DOD/OTHER AGENCIES:

FUTURE PLANS:

SOC ROADMAP -

VISION:

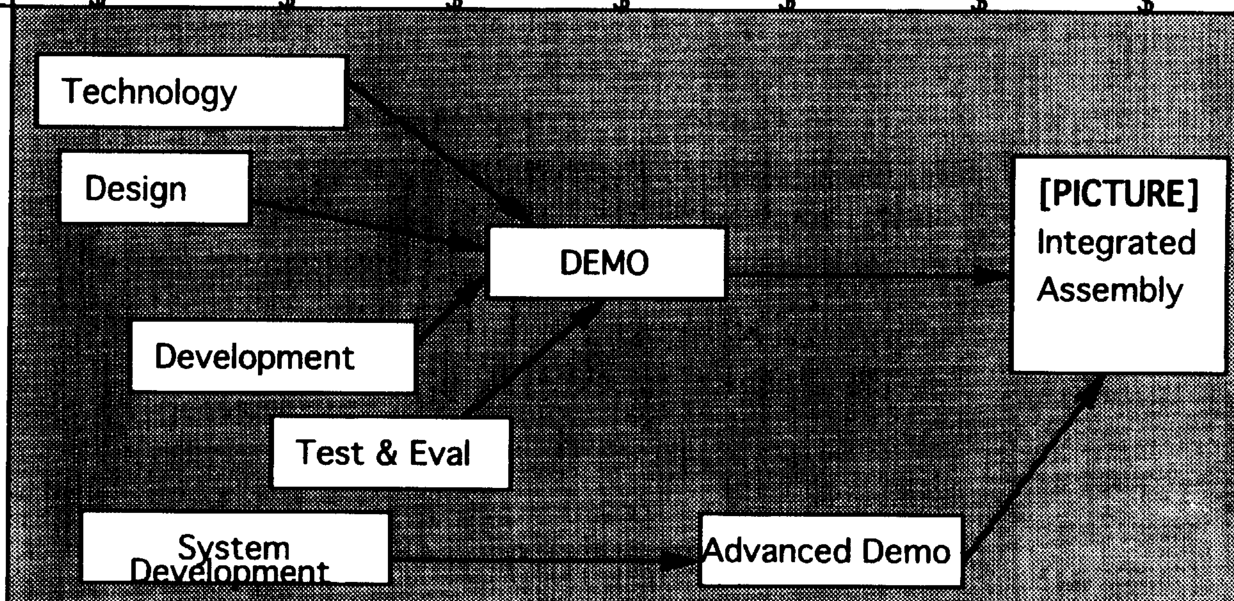
OBJECTIVE:

TECHNOLOGY AREA:

DISCIPLINE:

INVOLVEMENT					
NASA	AF	ARMY	NAVY	ARPA	DOE

FY94	FY95	FY96	FY97	FY98	FY99	FY00
$	$	$	$	$	$	$



DOD Key Personnel:

	AF	Army	Navy
Name			
Address			
Phone			

NASA Key Personnel:

Other:

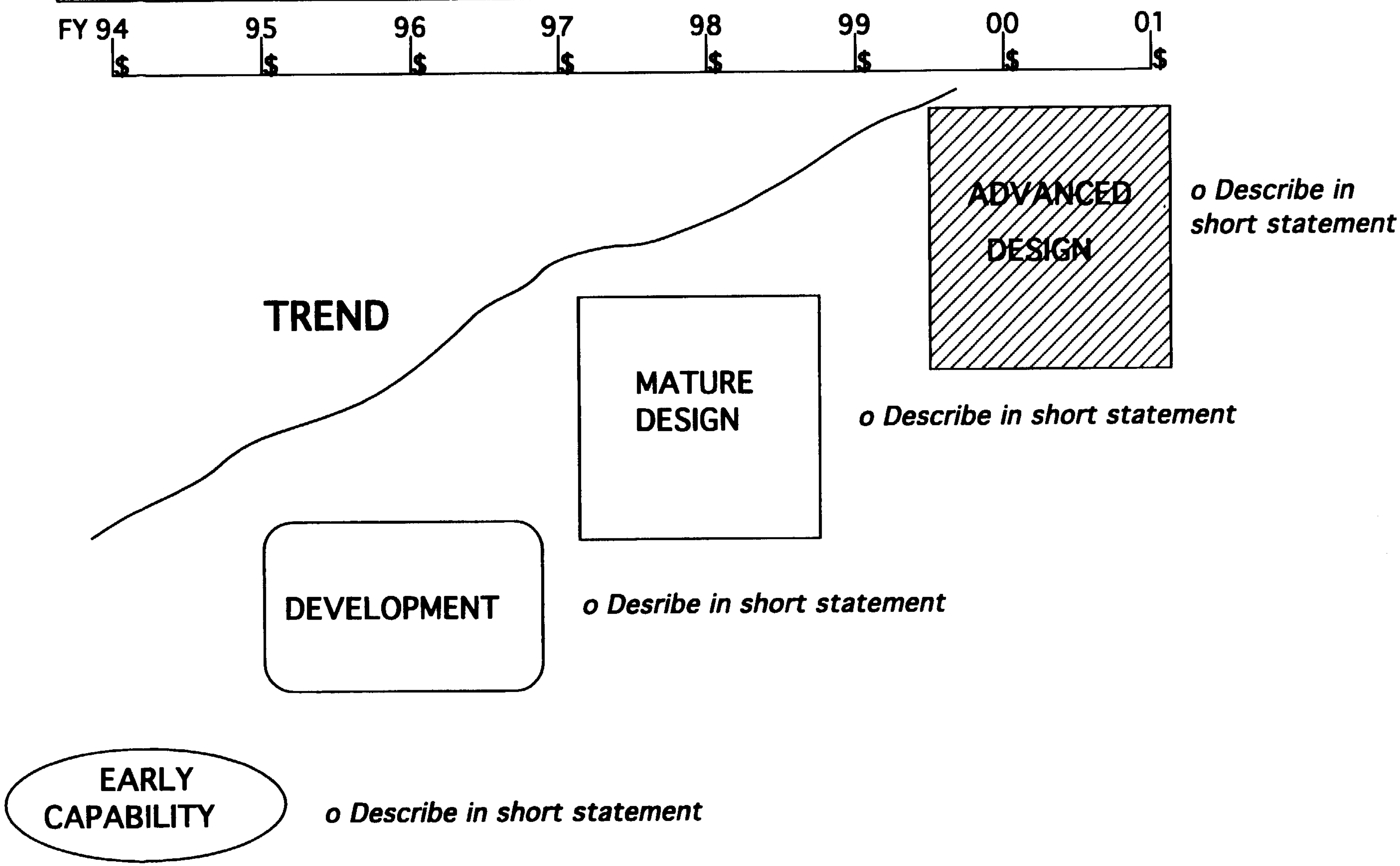
NASA CENTERS:

DOD/OTHER AGENCIES:

FUTURE PLANS:

[ROADMAP TITLE]

TECHNOLOGY GOAL: *(Short statement of development strategy)*



TECHNOLOGY PROCESS PLAN

PURPOSE: *The overall strategy of how the project will be accomplished.*

To briefly describe the management process by which the objective (s) will be successfully completed within the stated schedule and budget.

DESCRIPTION: *The following will be described for each project:*

- o RESOURCES AVAILABLE
  - $$$
  - PEOPLE
  - FACILITIES/ SITES
- o PRODUCTS
  - END ITEMS PRODUCED
  - QUANTITIES

Section 5

Meeting Attendees

STIG Operations Committee
February 3-4, 1994

Attendees

Ms. Lana Arnold	Lockheed	(713) 333-7112
Mr. Jerome Bell	NASA-JSC	(713) 483-4036
Dr. Mary M. Connors	NASA-ARC	(415) 604-6114
Mr. Ron Dickerman	USA SSD	(703) 607-2011
Mr. Daniel Eksuzian	Naval Air Warfare Ctr.	(215) 441-2331
Mr. Jerry Elliott	NASA-JSC	(713) 483-0819
Dr. Peter E. Friedland	NASA-ARC	(415) 604-4277
Lt. Col. Gerald Gleason	AF Armstrong Laboratory	(513) 255-8892
Captain Ron Julian	AF Armstrong Laboratory	(513) 255-3602
Dr. Kumar Krishen	NASA-JSC	(713) 483-0695
Col. Gerald P. Krueger	U.S. Army	(508) 651-4811
Dr. Jane T. Malin	NASA-JSC	(713) 483-2046
Dr. Richard L. Miller	AF Armstrong Laboratory	(210) 536-2091
Dr. Melvin Montemerlo	NASA Headquarters	(202) 358-4664
Mr. Don Nelson	NASA-JSC	(713) 483-0520
Dr. Andrew Pilmanis	AF Armstrong Laboratory	(210) 536-3545
Mr. Robert Savely	NASA-JSC	(713) 483-8105
Mr. Marc Shepanek	NASA Headquarters	(202) 358-2148
Captain Jim Skinner	Wright Laboratory	(513) 476-4500
Dr. Gerald Taylor	NASA-JSC	(713) 244-8796
Ms. Karen Thompson	NASA-KSC	(407) 867-3017
Dr. Charles Weisbin	NASA-JPL	(818) 354-2013
Captain Paul Whalen	AF Armstrong Laboratory	(513) 255-3671
Ms. Barbara Woolford	NASA-JSC	(713) 483-3701
Major Gary E. Yale	AF Phillips Lab	(505) 846-1289
*Mr. John Van Blois	The Aerospace Corp.	(407) 997-1144

* Invited guest

Section 6

SOC Technology Road maps

STIG Operations Committee

TECHNOLOGY ROAD MAPS

STIG

OPERATIONS COMMITTEE (SOC)

- AUTOMATION & INTELLIGENT SYSTEMS
- ROBOTICS & TELEPRESENCE
- HUMAN FACTORS
- LIFE SCIENCES

ROBOTIC EXPLORATION VEHICLES

VISION: To develop autonomous vehicles operating in harsh terrains and capable of reconnaisance, surveillance, data collection, and scientific experiments

OBJECTIVE: To augment soldiers in the field by enhancing autonomous search and destroy capability and to enable remote planetary exploration missions.

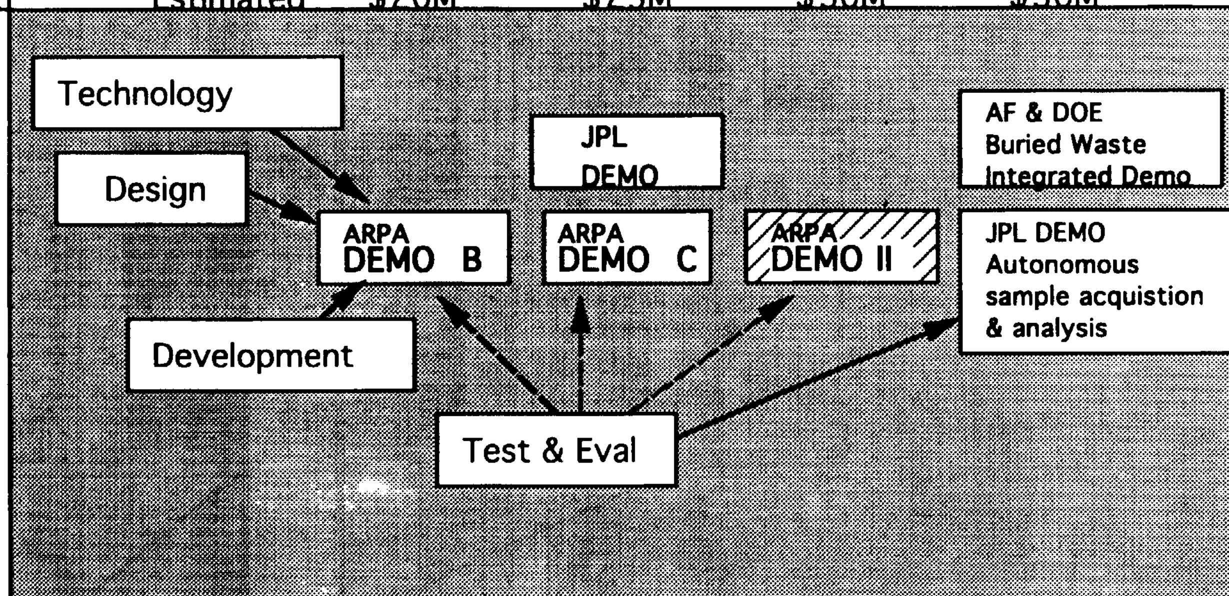
TECHNOLOGY AREA: Robotics & Telepresence

DISCIPLINE: Engineering

INVOLVEMENT

NASA	AF	ARMY	NAVY	ARPA	DOE
X	X	X	X	X	X
X	X	X		X	X
X		X		X	
X	X	X		X	X
X		X	X	X	X

	FY94	FY95	FY96	FY97
Estimated	$20M	$25M	$30M	$30M



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Dave Strip, Sandia Lab, DOE, 505/844-3962
Joe Herndon, ORNL, DOE, 615/576-0119
Capt. Paul V. Whalen, USAF AL/CFBA, WPAFB 513/255-3671

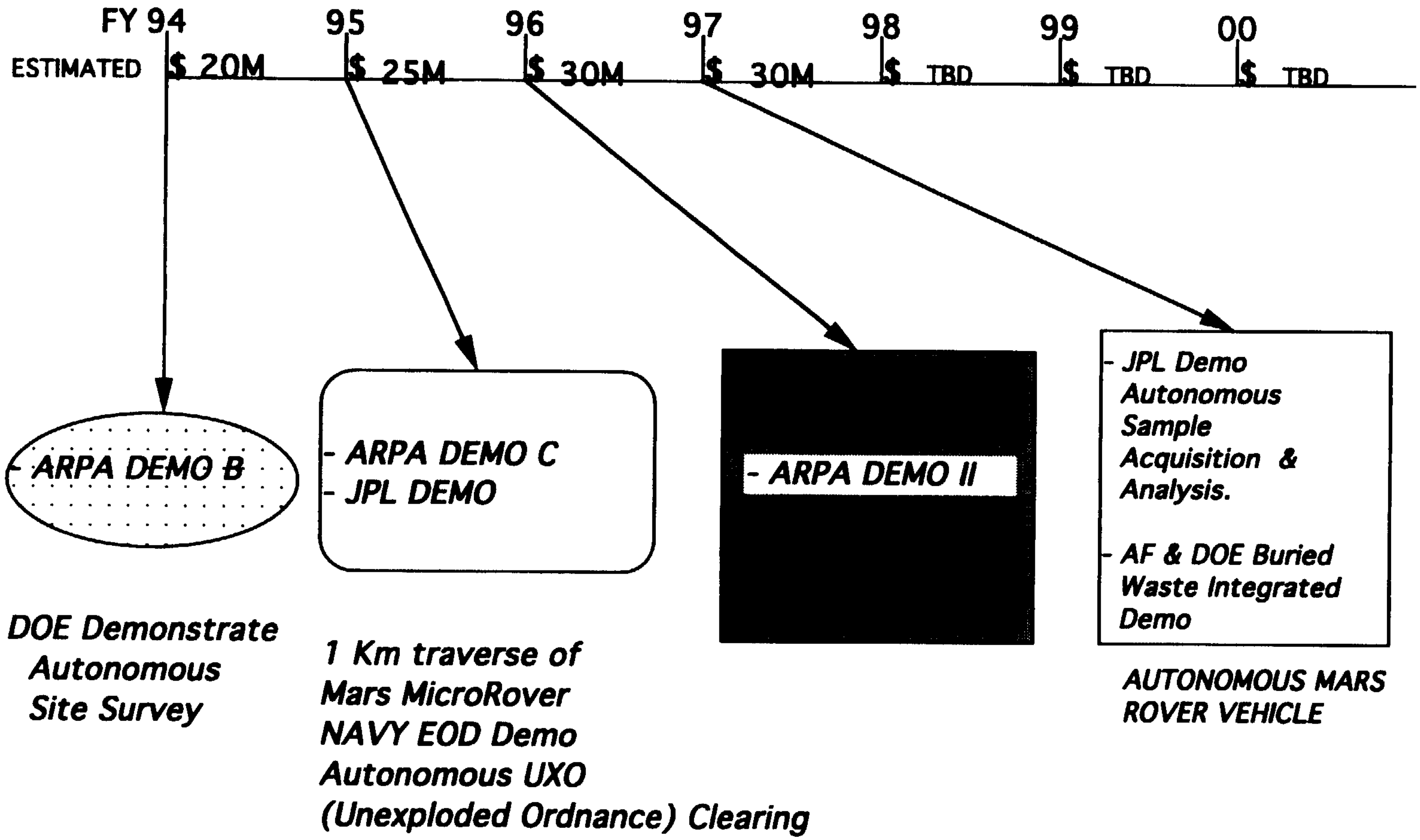
NASA CENTERS: NASA CODE C/JPL

DOD/OTHER AGENCIES: ARPA, NAVY (EOD), DOE (ORNL, SANDIA), ARMY (TACOM) , AF (AFMC)

FUTURE PLANS: Autonomous navigaton in unstructured environments, low-bandwidth communications and control, pattern recognition, miniature actuators, etc. Stereo vision from JPL developments will be used in ARPA Unmanned Ground Vehicle (UGV) project and by AF unexploded ordnance (UXO) clearance project.

ROBOTIC EXPLORATION VEHICLES

TECHNOLOGY GOAL: ***To develop autonomous vehicles capable of operating in harsh terrains and capable of reconnaisance, surveillance, data collection, and scientific experiments.***



AUTOMATED/TELEROBOTIC MAINTENANCE & SERVICING

VISION: Systems performing complex maintenance & servicing in remote environments.

OBJECTIVE: To develop technologies for remote inspection, autonomous supply replenishment, surveillance and remote manipulation. Autonomous and semi-autonomous remote manipulation of delicate objects, force feedback for human interface to telerobotic systems, pattern recognition, robust control.

TECHNOLOGY AREA: Robotics & Telepresence

DISCIPLINE: Engineering

INVOLVEMENT					
NASA	AF	ARMY	NAVY	ARPA	DOE
X	X	X	X	X	X

	FY94	FY95	FY96	FY97	FY98
Estimated	$15M	$18M	$22M	$25M	$TBS

- USAF Validate Unified Telerobotic Architecture
- Ground Controlled Autonomous Inspection for Space Station
- Area Clearance/ Buried Waste Automated Technology
- Dexterous Orbiter Servicing System Operating in Shuttle Bay

DOD Key Personnel:

	AF	AF	ARMY
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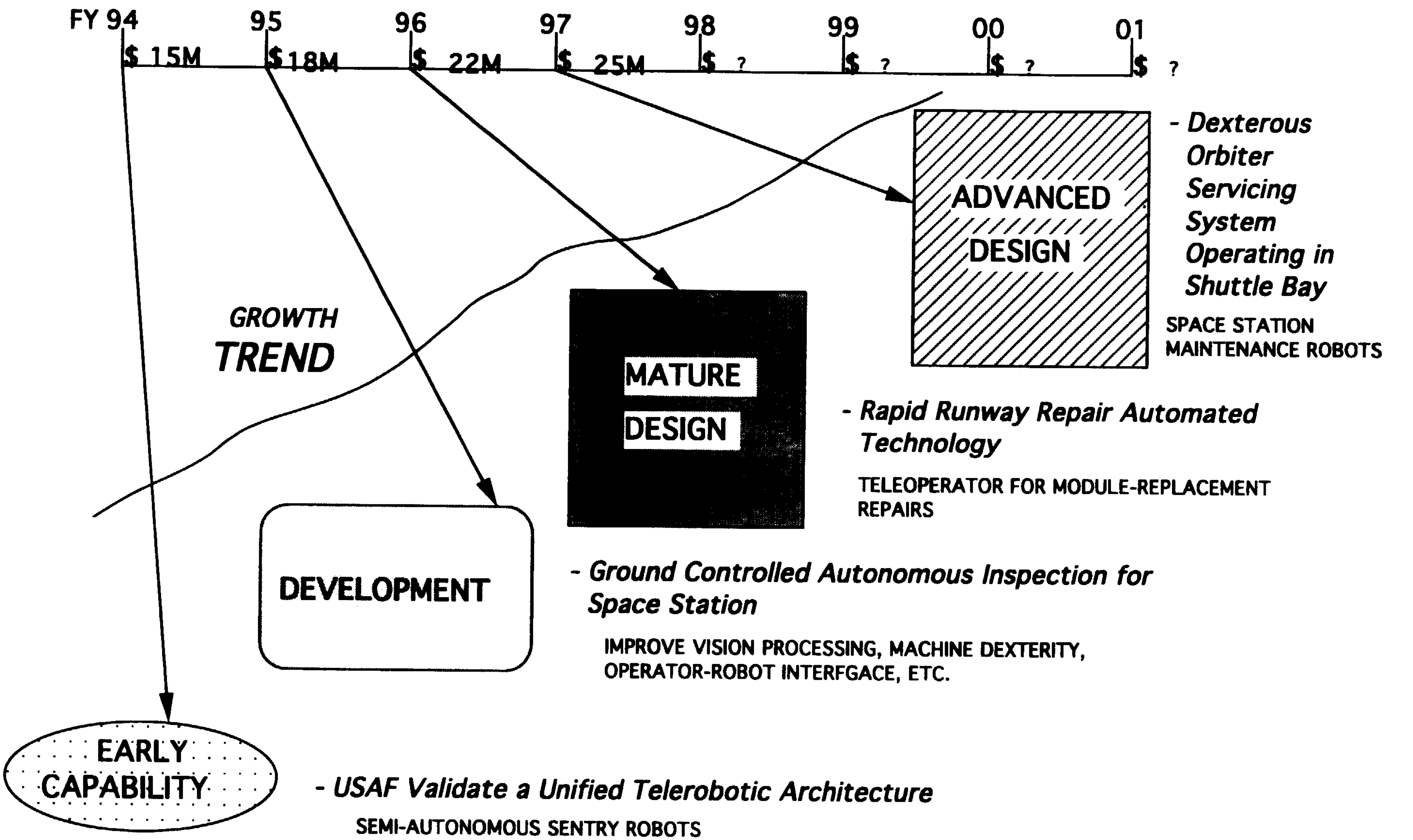
NASA CENTERS: NASA (KSC, JSC, JPL, GSFC)

DOD/OTHER AGENCIES: DOE (ORNL, Sandia), AF (AFMC), ARMY ARL

FUTURE PLANS: NIST is validating the Unified Telerobotics Architecture (UTA) for the AF. DOE technology for hazardous waste storage tanks will be applied to AF logistics operations. The vision system developed at JPL will be applied in the UXO area clearance system. DOE technology for hazardous waste storage tanks will be applied to AF logistics operations while AF will support DOE's Buried Waste Integrated Demo. AF is supporting DOE Buried Waste Integrated Demo.

AUTOMATED AND TELEROBOTIC MAINTENANCE & SERVICING

TECHNOLOGY GOAL: *To develop technologies for remote inspection, autonomous supply replenishment, surveillance and remote manipulation. Autonomous and semi-autonomous remote manipulation of delicate objects, force feedback for human interface to telerobotic systems, pattern recognition, & robust control.*



ARTIFICIAL INTELLIGENCE

VISION: Improved Productivity, Reliability And Safety At Reduced Costs Through Machine Intelligence.

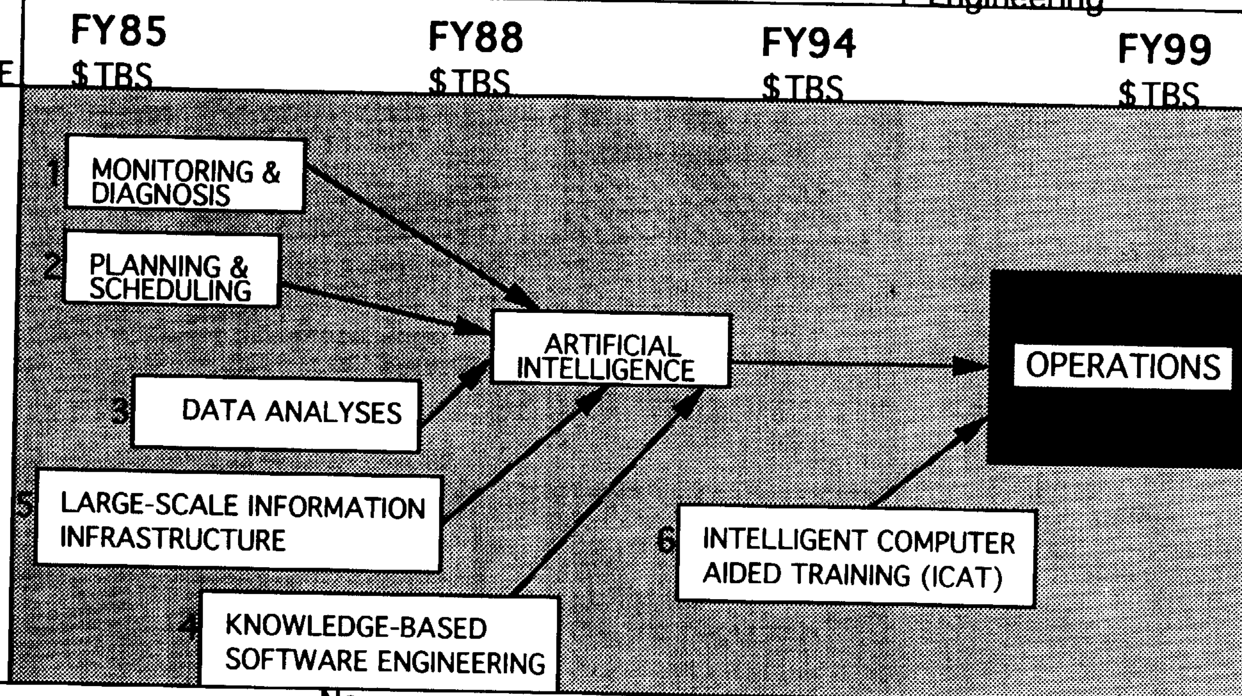
OBJECTIVE: Maintain Safe And Cost Effective Access & Exploitation Of Space.

TECHNOLOGY AREA: Artificial Intelligence

DISCIPLINE: Engineering

INVOLVEMENT

NASA	AF	ARMY	NAVY	ARPA	DOE
X	X	X	X	X	
X	X	X	X	X	
X	X	X	X	X	
X	X	X	X	X	
X	X	X	X	X	
X	X	X	X	X	



DOD Key Personnel:

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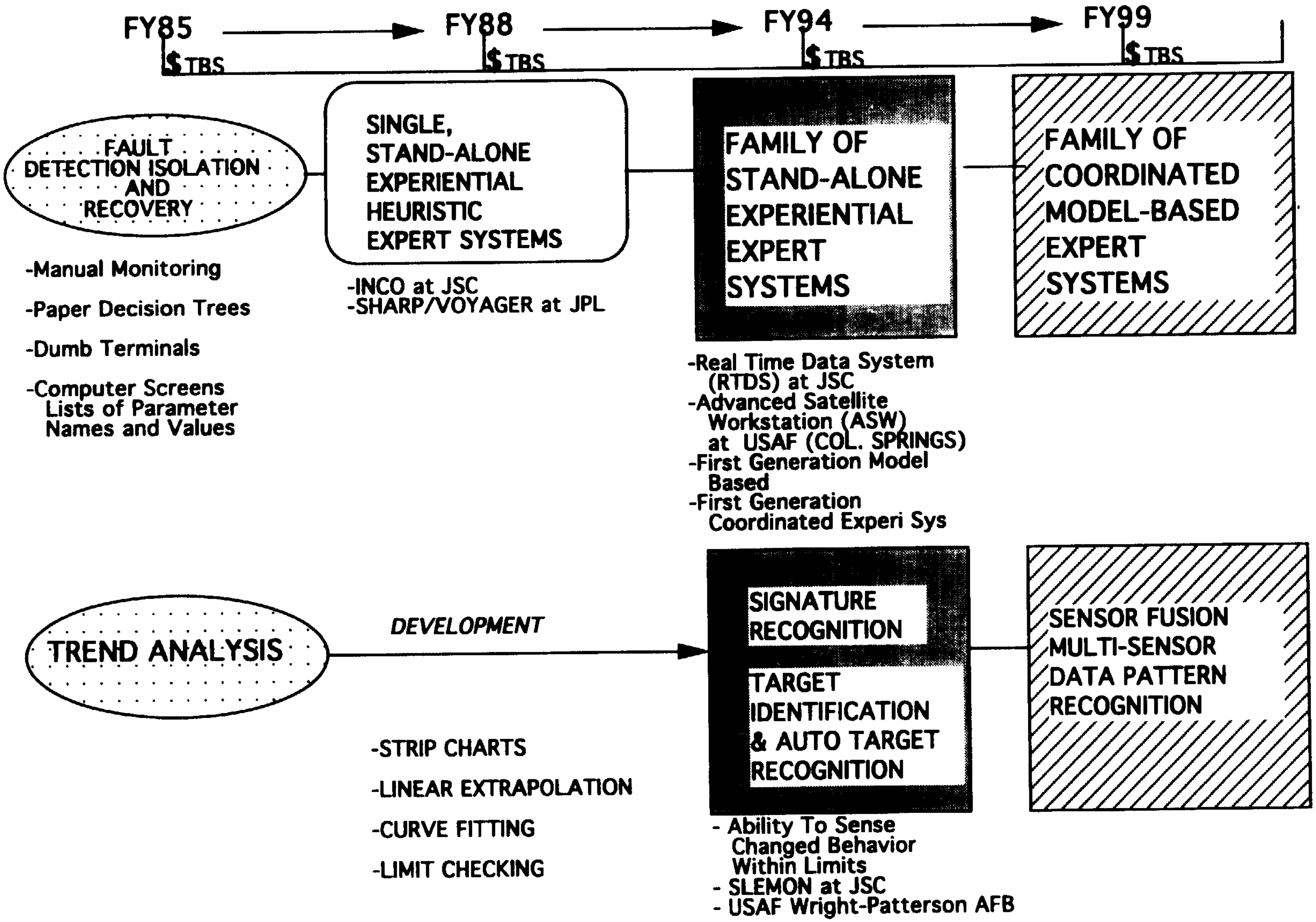
NASA CENTERS: NASA HEADQUARTERS, JPL, JSC, ARC.

DOD/OTHER AGENCIES: AIR FORCE (USAF) Rone Laboratory;Wright Laboratory, Armstrong Laboratory, Phillips Laboratory.

FUTURE PLANS: Families of coordinated model-based expert systems, capability to diagnose unforseen anomalies, on-board real-time system health maintenance systems, sensor fusion, failure prediction from on-board.

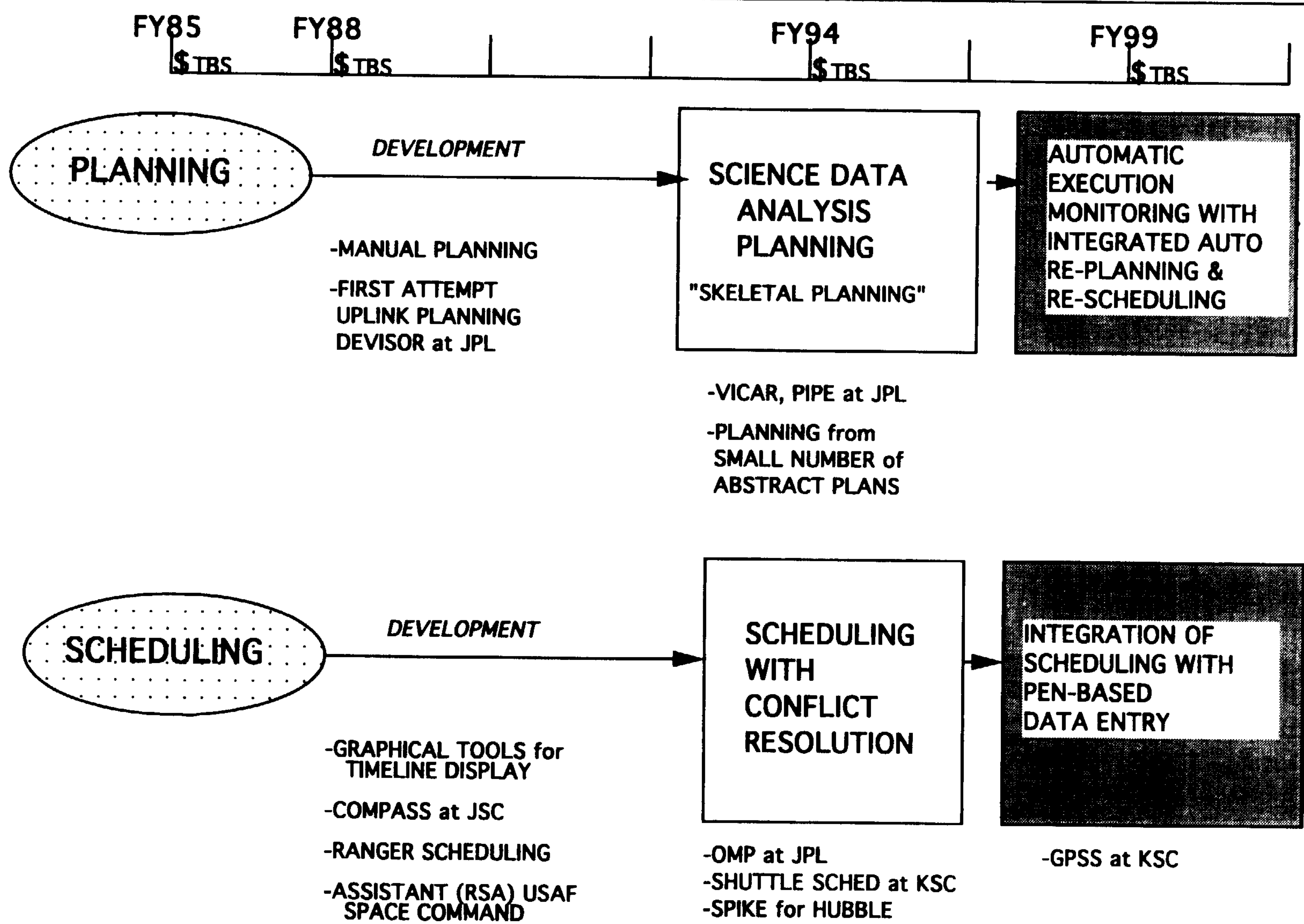
ARTIFICIAL INTELLIGENCE - Monitoring & Diagnosis

TECHNOLOGY GOAL:
(1) Capability to diagnose unforseen anomalies;
(2) On-board real-time Health Maintenance Systems;
(3) Failure prediction from on-board



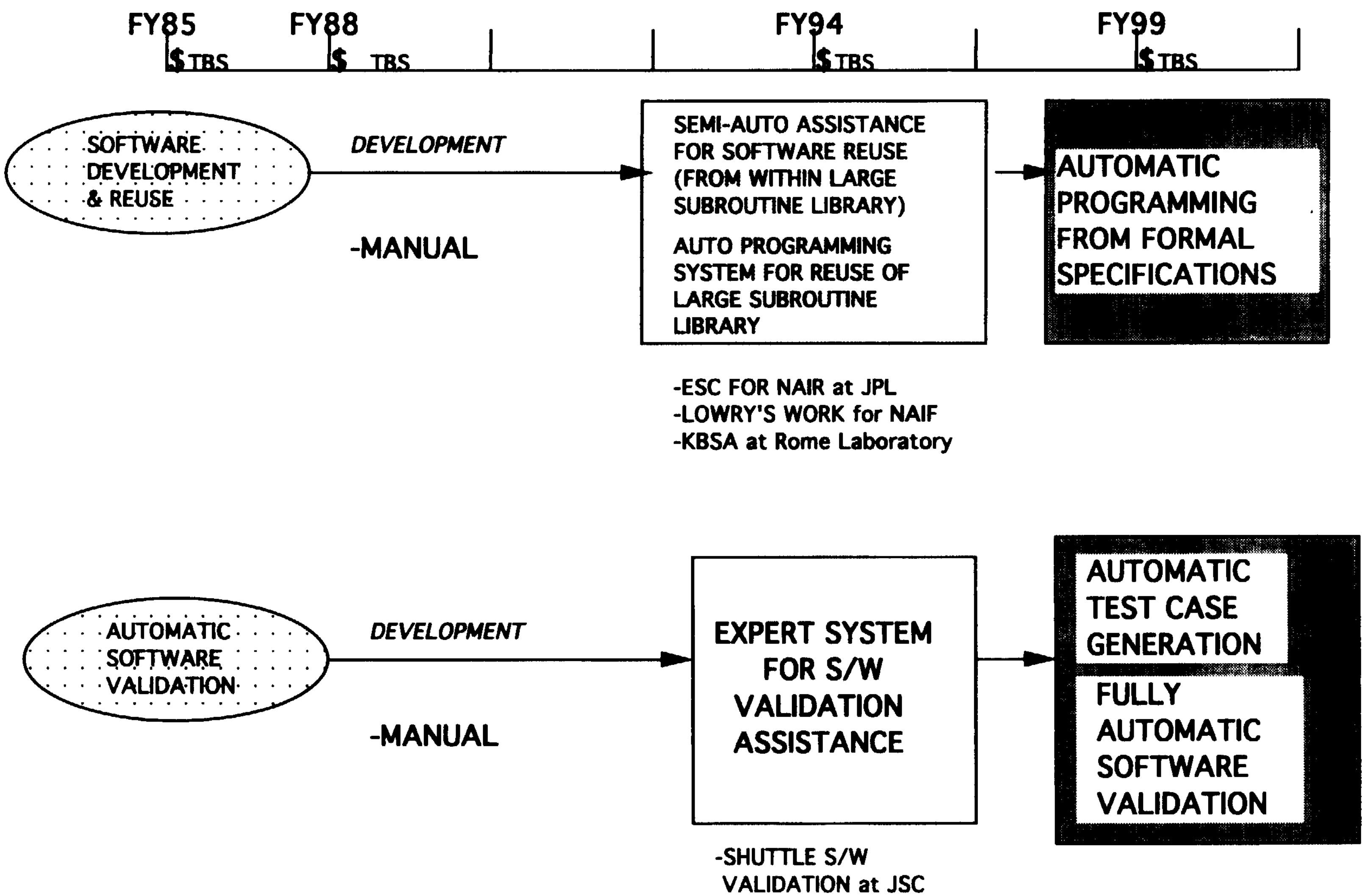
ARTIFICIAL INTELLIGENCE - Planning & Scheduling

TECHNOLOGY GOAL: Reactive "Anytime" Scheduler



ARTIFICIAL INTELLIGENCE - Knowledge-Based Software Engineering (KBSE)

TECHNOLOGY GOAL: (1) Automatic Programming from Forma Specifications;
(2) Fully Automatic Software Validation.



ARTIFICIAL INTELLIGENCE - Data Analysis

TECHNOLOGY GOAL: (1) Automatic Theory formulation;
(2) 3-D Visualization

FY85 $ TBS | FY88 $ TBS | FY94 $ TBS | FY99 $ TBS

CLASSIFICATION — DEVELOPMENT →

-SUPERVISED CLASSIFICATION OF MASSIVE DATASETS

-CLASSIFICATION OF IMAGE DATA
eg. SKICAT-PALOMAR IMAGES

-TARGET ID & RECOG. VIA NEURAL NETS (USAF)

→ [redacted]

First Generation of Unsupervised Class Determination
eg - AUTOCLASS-IRAS

MODEL BUILDING — DEVELOPMENT →

-STATISTICAL MODELLING OF SINGLE BIT STRINGS
eg. TDAG at JSC

-TOOLSET FOR BUILDING DATAFLOW MODELS OF SCIENTIFIC PHENOMENA
eg. SIGMA at ARC

→ [redacted]

Numeric Interpolation
(Curve Fitting)

VISUALIZATION & DATA FUSION — DEVELOPMENT →

-COLOR COMPUTER GRAPHICS IN 2-D

-3-D GRAPHICS ON 2-D SCREEN

-PILOT'S ASSOCIATE & ROTORCRAFT ASSOC. (USAF)

→ [redacted]

-CORE DUMPS

-Old JSC Mission Control Displays of Parameter Names and Hexadecimal Values

-Statistical, Numerical Approaches

ARTIFICIAL INTELLIGENCE - Large Scale Information Infrastructure

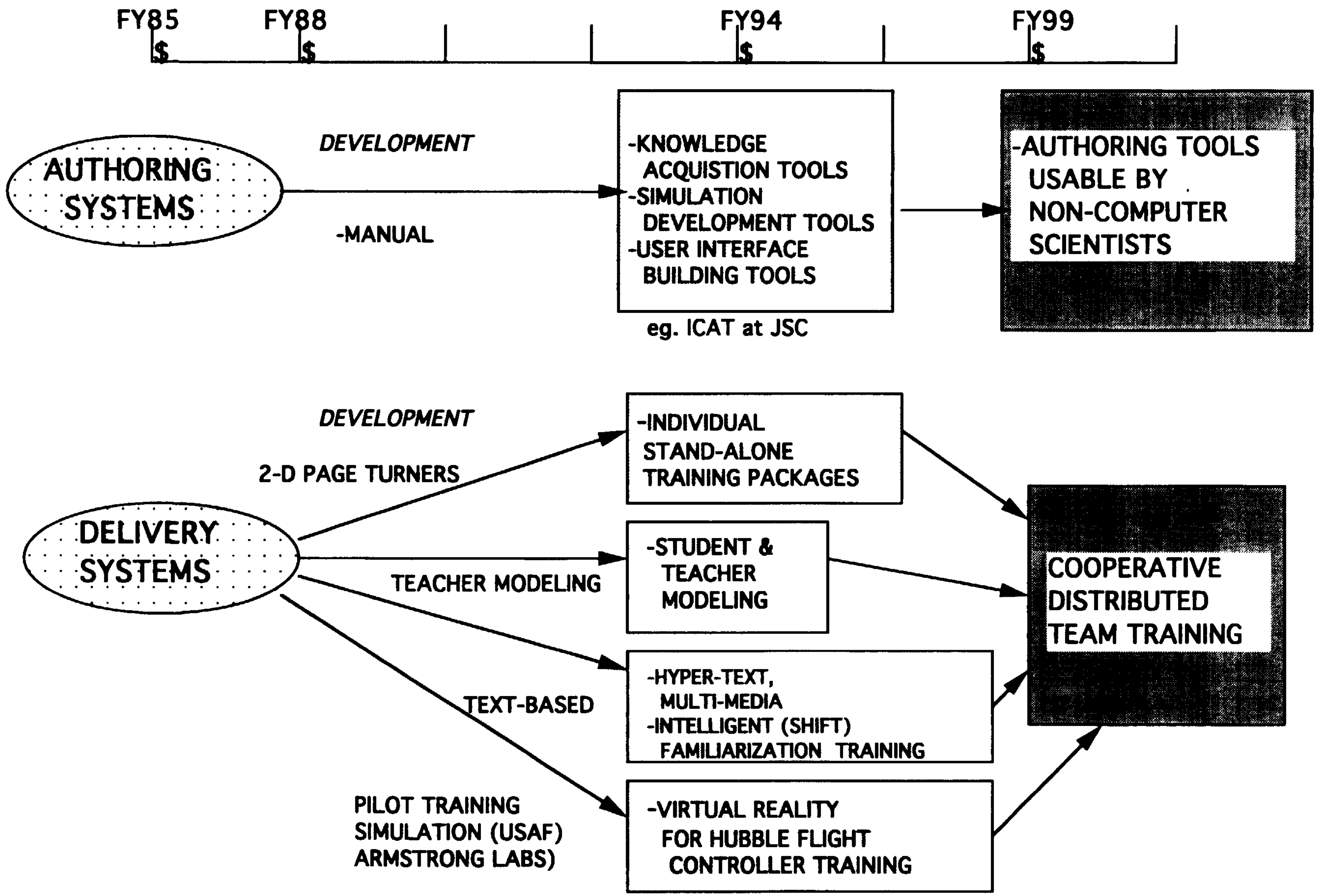
TECHNOLOGY GOAL: Inexpensive and Ubiquitous Access to Information.

FY85 $ TBS — FY88 $ TBS — FY94 $ TBS — FY99 $ TBS

INTERNET -FILE TRANSFER ON INTERNET 1 K-BYTE/SEC OVER NETWORK WITH 1K NODES	*DEVELOPMENT* -USED BY SMALL FRACTION OF NASA COMMUNITY	-INTERNET WITH 20 MILLION USERS, 2 MILLION SERVERS 1 MEGABYTE/SEC -GOPHER, MOSAIC, WORLD WIDE WEB -MODUS OPERANDI FOR COMP. SCIENCE RESEARCH -SIMNET - 6 SITES	[redacted]
ELECTRONIC DOCUMENTATION	*DEVELOPMENT*	-FIRST APPLICTION OF ELECTRONIC FORMS FOR INFRASTRUCTURE	[redacted]
ARCHIVING & RETRIEVAL	*DEVELOPMENT* -RELATIONAL DATA BASE	-INITIAL ATTEMPTS AS OBJECT ORIENTED DATABASES	[redacted]
COMMERCIAL REMOTE SENSING	*DEVELOPMENT*	-ONLY COMPUTER EXPERTS CAN USE THE NETWORKS & DATA BASES -EACH CUSTOMER REQUEST MUST BE FILLED MANUALLY	[redacted]

ARTIFICIAL INTELLIGENCE - Intelligent Computer Aided Training

TECHNOLOGY GOAL: Provide Practical Authoring Tools for Use By Non-computer Scientists.



MAN-MACHINE INTEGRATION DESIGN & ANALYSIS SYSTEM(MIDAS)

VISION: To reduce aircraft life-cycle costs by improving conceptual design through the use of integrated modeling. To conduct & integrate the applied research necessary to develop an engineering environment containing the tools & models needed to assist crew station developers in conceptual design.

OBJECTIVE: To develop a model & principle-based human factors methodology to aid in the conceptual design of crew stations and to produce prototype workstations that move man-machine design iterations from hardware to s/w.

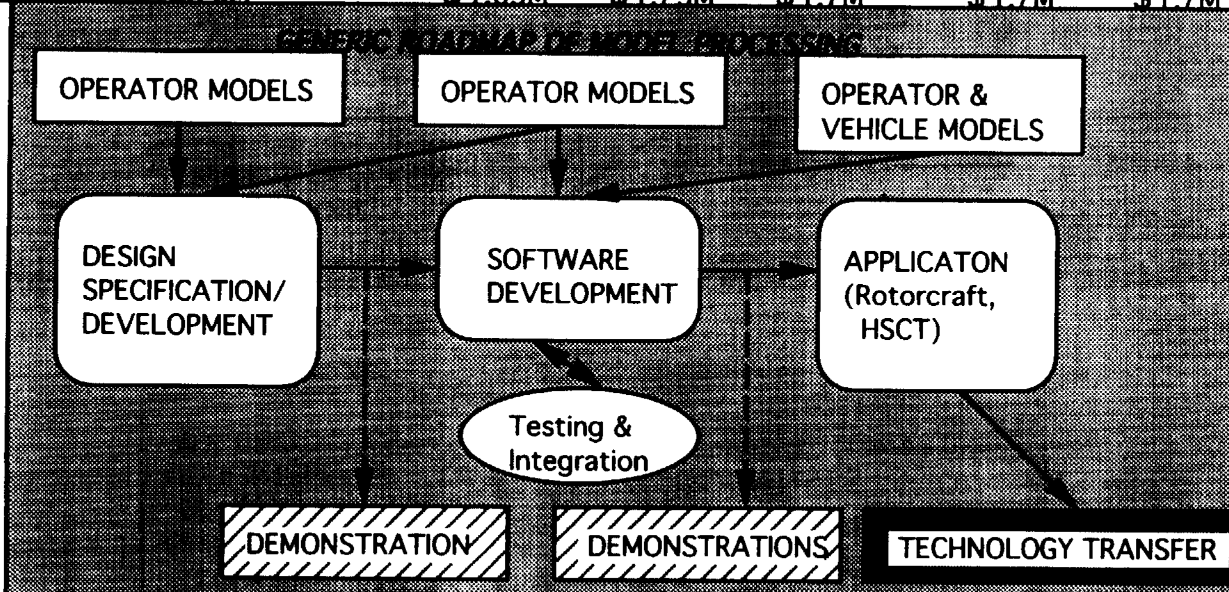
TECHNOLOGY AREA: Human Factors

DISCIPLINE: Life Sciences

INVOLVEMENT

NASA	AF	ARMY	NAVY	ARPA	DOE
X		X			
X		X			
X		X			
X		X			
X		X	X		

PRIOR YEARS	FY93	FY94	FY95	FY96	FY97
$12.75M	$1.65M	$1.75M	$1.7M	$1.7M	$1.7M



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Phone:			

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NASA CENTERS: NASA/Ames Research Center/Aerospace Human Factors Research Division

DOD/OTHER AGENCIES: USA/Air Vehicle Technology/Man-Machine Integration

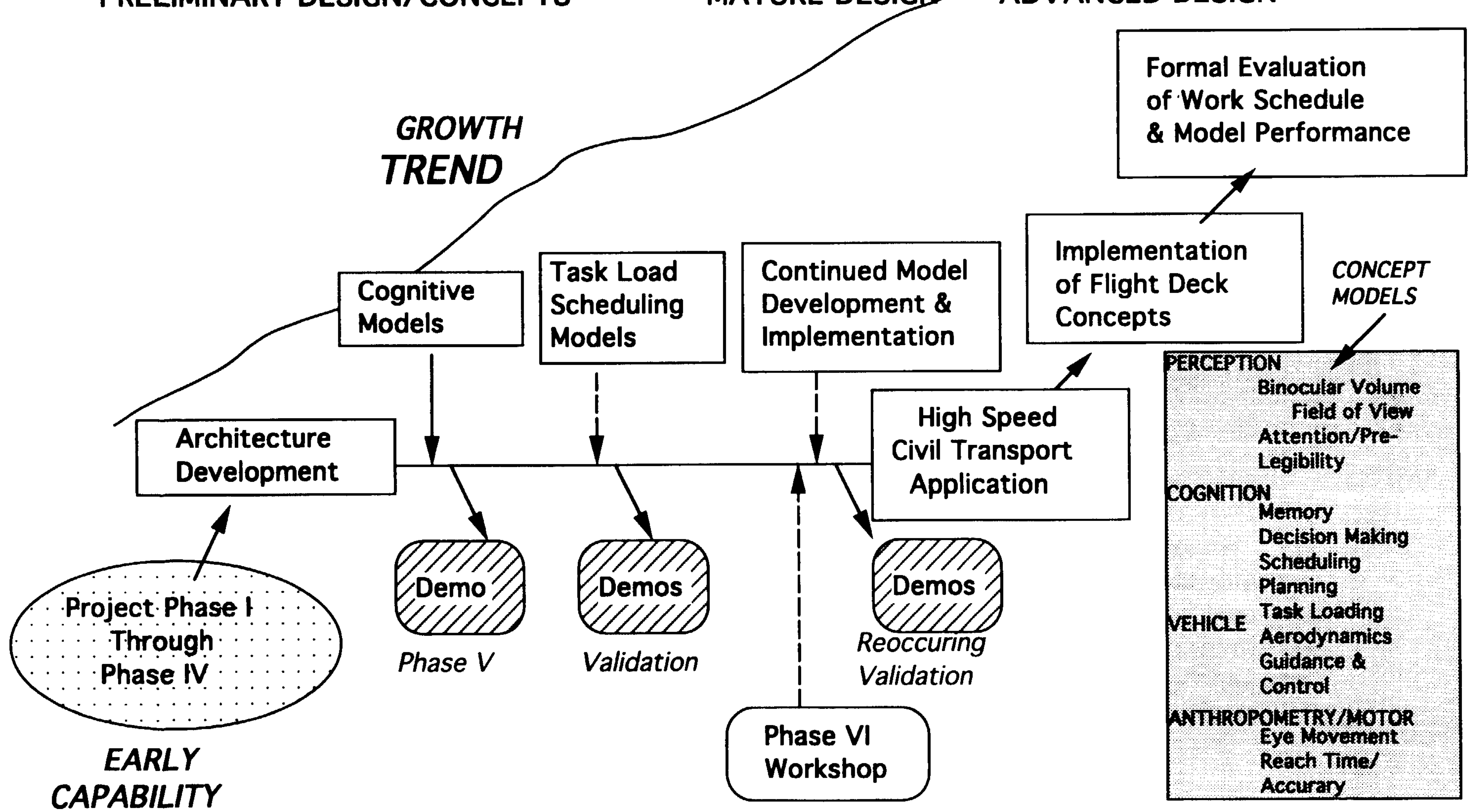
FUTURE PLANS: To demonstrate MIDAS's value to the aerospace design community and to effect a transfer of the technology to industry and other government agencies. 70 - 80% of the life-cycle of an aircraft is determined in the conceptual design stage; MIDAS addresses this conceptual design stage.

MAN-MACHINE INTEGRATION DESIGN & ANALYSIS SYSTEM (MIDAS)

TECHNOLOGY GOAL: To reduce aircraft life-cycle costs by improving conceptual design through the use of integrated modeling.
To develop a model & principle-based human factors methodology to aid in the conceptual design of crew stations and to produce prototype workstations that move man-machine design iterations from hardware to software.

PRIOR YEARS 84 to FY 92	93	94	95	96	97
$12.75M	$1.65M	$1.75M	$1.7M	$1.7M	$1.7M

PRELIMINARY DESIGN/CONCEPTS — MATURE DESIGN — ADVANCED DESIGN



Background

MIDAS is a joint Army-NASA applied research effort to develop computation models for human engineering design of advanced technology crew stations. Begun in 1984, the first few years saw the development of design specifications and Phase I demonstration. From 1986 to 1990, the core software was developed and modified and Phases II-IV demonstrated. In the 1991-1992 time frame, new agent architecture and cognitive models were incorporated, and the Phase V demonstration completed. To date, the models incorporated within MIDAS include the following categories: Perception, Cognition, Vehicle, World and Anthropometry/Motor.

Major Milestones

The following are major milestones for FY 93 and beyond:

FY 93 - Port symbolic code to SGI platform - MIDAS on one workstation
FY 94 - Implement baseline design geometry
FY 95 - Apply design to NASA high speed civil transport
FY 96 - Implement industry and NASA flight deck concepts
FY 97 - Formally evaluate workstation & model performance

Management Approach

The Computational Human Engineering Research Office (CHERO), organized under the Army's Aeroflightdynamics Directorate and NASA's Aerospace Human Factors Research Division at NASA-AMES holds primary responsibility for program management, software development and funding support. CHERO reports to both the Army and the NASA chains of command at Ames Research Center. Building upon CHERO's core research and development achievements, the Navy and industry collaborators contribute to transitioning the technology into real world applications.

End Products/Users

The MIDAS program potentially benefits all crew station designers. The early adopters have been from the aeronautics community. An arrangement with a leading airframe manufacturer has been established and codes are being transitioned for their use. The airframe manufacturer is providing real-world data which is being used to continue the MIDAS validation process. Although the project is directed primarily towards aero and space applications, its use is not restricted to these areas. MIDAS is also being actively pursued in support of emergency services and nuclear power plant workstation design.

VIDEO DISPLAY ENGINEERING & OPTIMIZATION SYSTEM (ViDEOS)

VISION: To support the domestic, flat-panel display industry with computer-aided design (CAD) tools.

OBJECTIVE: To produce a CAD system for optimizing engineering performance and system integration of Active Matrix Liquid Crystal Displays (AMLCD); to evaluate performance based on quantitative analysis of visual function & image quality metrics; and to relate fundamental device parameters to visual performance.

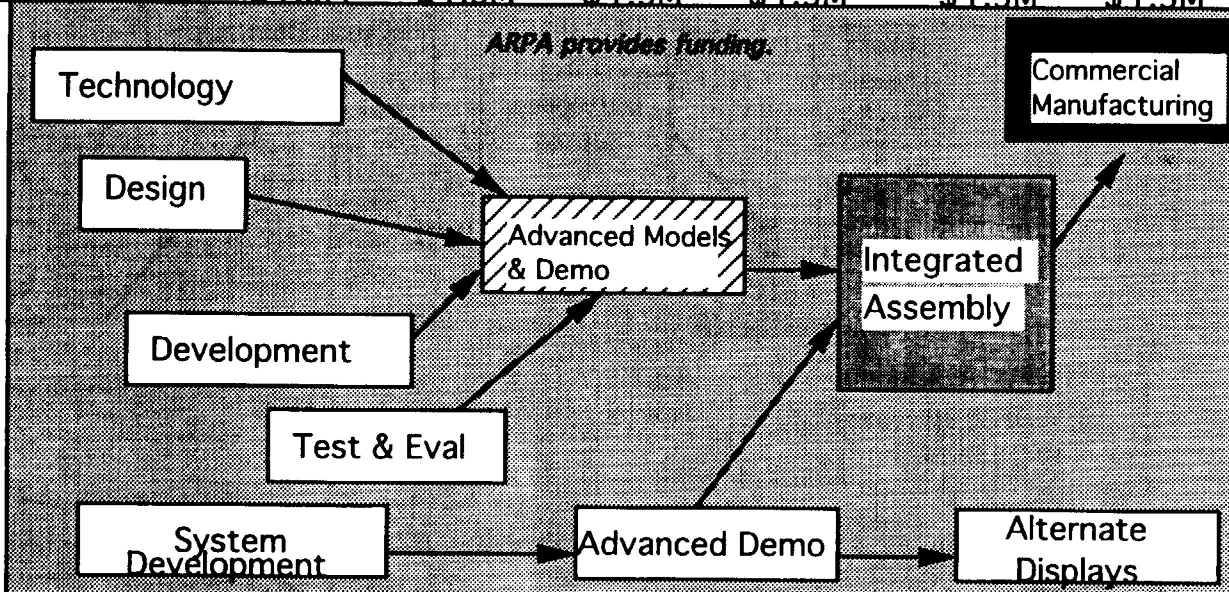
TECHNOLOGY AREA: Human Factors

DISCIPLINE: Life Sciences

INVOLVEMENT

NASA	AF	ARMY	NAVY	ARPA	DOE
X				X	
X				X	
X				X	
X				X	
X				X	
X				X	

FY91	FY92	FY93	FY94	FY95	FY96	FY97
$1.5M	$1.5M	$1.5M	$1.5M	$1.5M	$1.5M	$1.5M



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Optical Imaging Systems inc. (OIS)
Kent State University
University of Virginia
Univ. of Wisconsin/Stanford Univ.
Xerox, PARC/VCD Sciences, Inc.
Dwight Berreman, Consultant

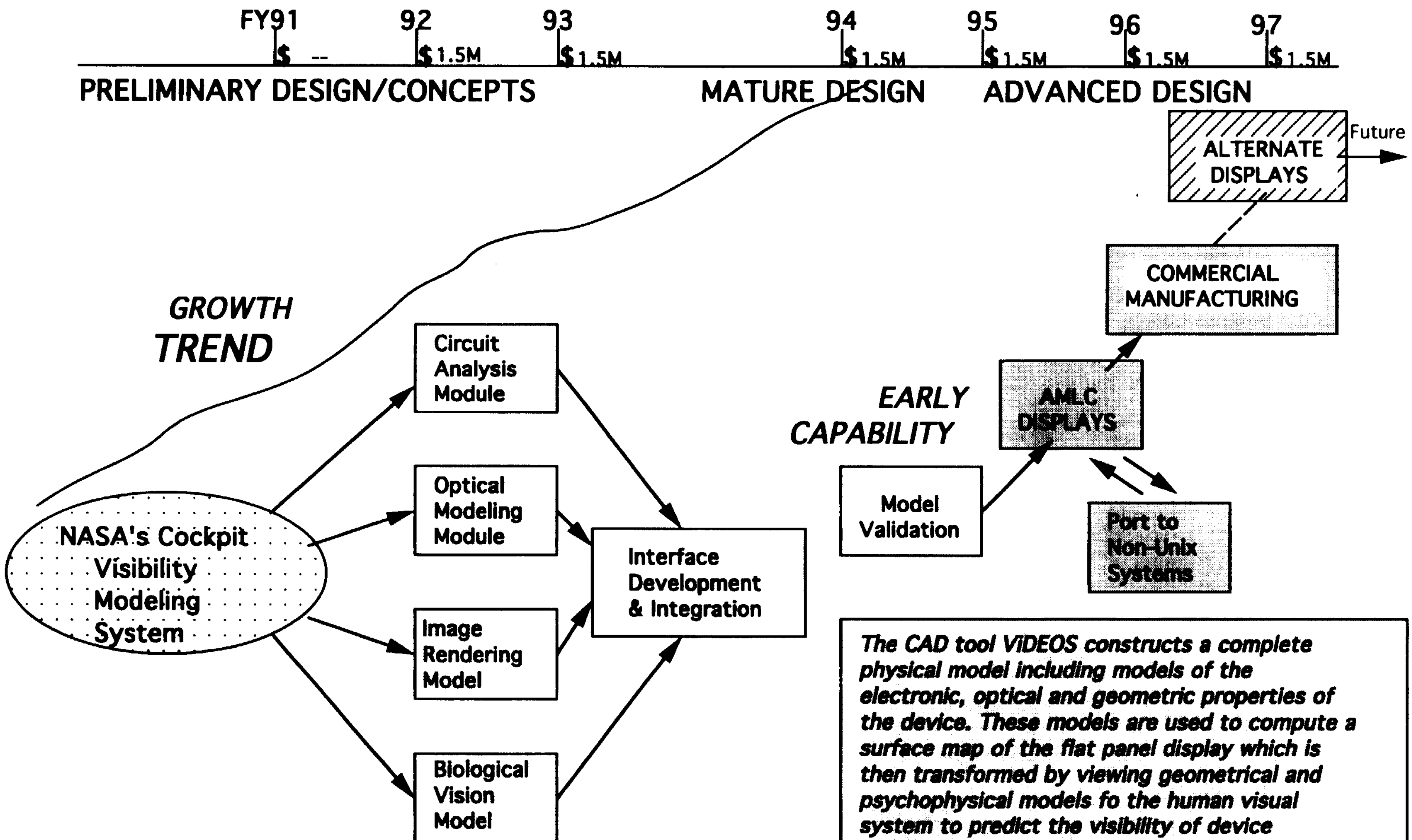
NASA CENTERS: NASA-Ames Research Center/Aerospace Human Factors Research Division

DOD/OTHER AGENCIES: Sponsoring Organization: ARPA-High Resolution Systems

FUTURE PLANS: To build an end-to-end (electrons to neurons) computer modeling and simulation system of human early vision response to flat panel displays.

VIDEO DISPLAY ENGINEERING & OPTIMIZATION SYSTEM (ViDEOS)

TECHNOLOGY GOAL: To support the domestic, flat-panel display industry with computer-aided design (CAD) tools.



The CAD tool ViDEOS constructs a complete physical model including models of the electronic, optical and geometric properties of the device. These models are used to compute a surface map of the flat panel display which is then transformed by viewing geometrical and psychophysical models fo the human visual system to predict the visibility of device artifacts such as flicker and jiggles.

Background

Prior to the initiation of ViDEOS, Ames Research Center had been involved in a Cockpit Visibility Modeling Systems project, undertaken to develop CAD tools for modeling cockpit displays. In 1991, the project came to the attention of the Defense Advanced Research Projects Agency's (DARPA) High Resolution Systems Program, which was seeking out technologies that could support the US flat panel display industry. In putting together their approach to flat-panel display, DARPA assembled an extremely diverse team (see Participating Organizations) to ensure that all aspects of display development are covered. Ames Research Center was given responsibility for the modeling element of the program.

Major Milestones

The following are major milestones for FY 92 and beyond:

Dec. 92 - Case studies for domestic industries

Dec. 93 - Release of Version 1 Liquid Crystal Display tool (Liquid Crystal Optics Design Package)

Dec. 94 - Release Display Tool and Visual Tool. *

Dec. 95 - Assemble integrated system

* *Note: Display tool is a surface modeling software package for constructing surface maps of flat panels. Visual Tool is a model of early human vision and is used to detect display artifacts such as flicker and stair stepping.*

Management Approach

ARPA has overall management responsibility for the High Resolution Systems Program. Elements of that program include research on: materials, machine tools, device prototyping, manufacturing and modeling. NASA-Ames Research Center has the overall responsibility for managing the modeling element of the program. This responsibility includes interactions with potential commercial developers and the development and testing of the various phases of the ViDEO system.

End Products/Users

The current focus is on developing an end-to-end tool for designing Active Matrix Liquid Crystal Displays (AMLCD). Later versions of ViDEOS will include other flat panel display types. Various American companies have, and are, participating in this development effort. Various American Companies have, and are participating in this effort. The three US companies building active matrix LCDs have already adopted an early version of ViDEOS in support of developing prototype displays.

HUMAN WORKLOAD MODELING

VISION: To contribute to the development of the scientific and technological foundations for safe and productive human presence in space.

OBJECTIVE: To access the utility of task network modeling for studying: Function allocation strategies; effects of temporal, biological and environmental stressors on human performance; 0-g and partial-g effects on human performance; psychomotor, perceptual, & information-processing capabilities of the human operator; and effects of circadian and diurnal rhythms, sustained performance, and work-rest ratio, crew-coord. perform.

TECHNOLOGY AREA: Human Factors

DISCIPLINE: Life Sciences

INVOLVEMENT					
NASA	AF	ARMY	NAVY	ARPA	DOE
X	X				

FY95 →	FY96	FY97
$TBS	$TBS	$TBS

Design — FRONT-END ANALYSIS

Development — MODEL DEVELOPMENT

Test & Eval. — WORKLOAD COMPONENT SCALE DEVELOPMENT

Future — Advanced Models & Demo

Task Network workload modeling tool will provide mission planners with a method for :

1) [illegible] allocation of mission tasks
2) [illegible] formulation of timelines and schedules
3) [illegible] equipment design
4) [illegible] of the feasibility of proposed missions

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713/483-3701

Other:

None.

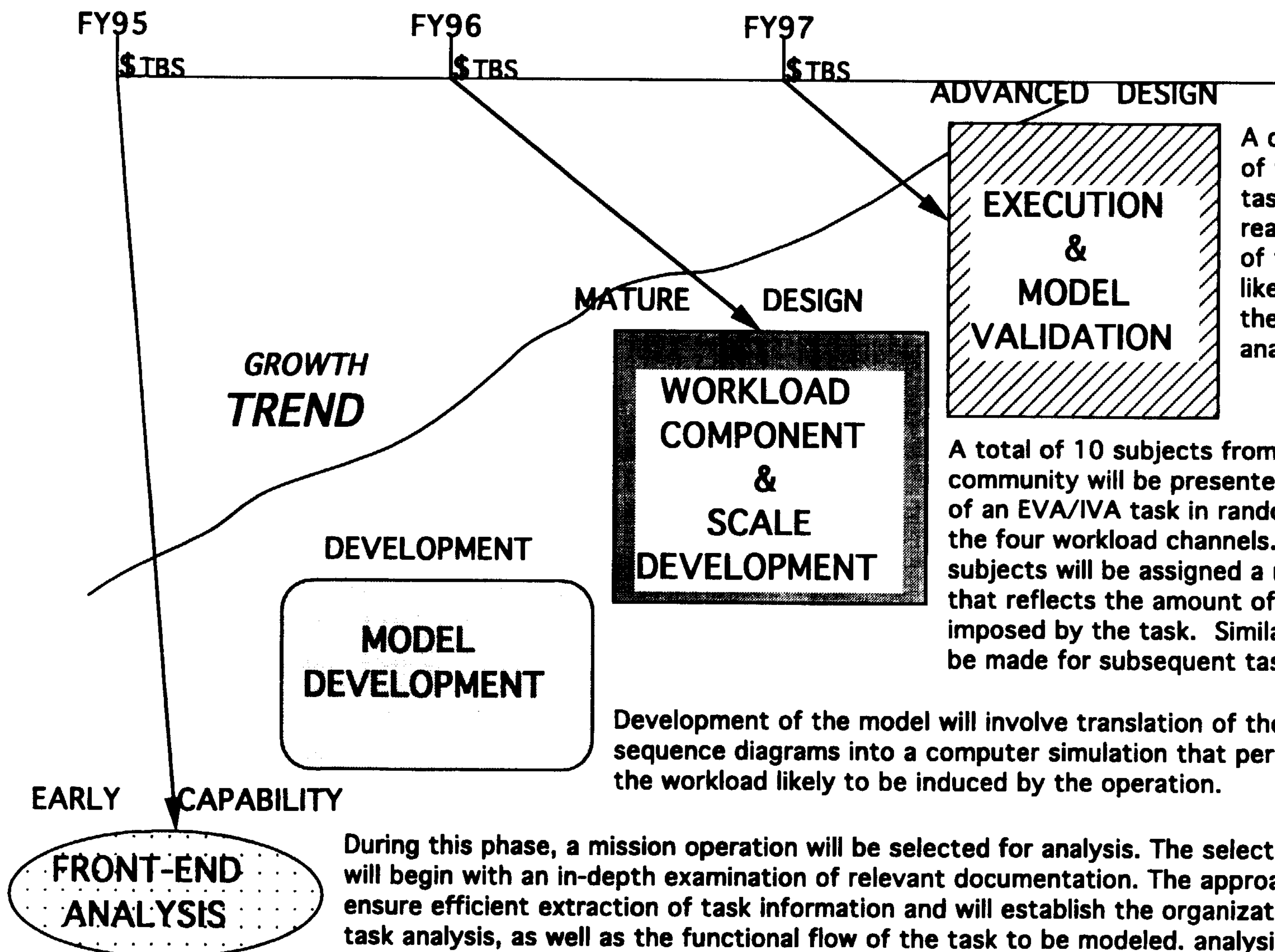
NASA CENTERS: NASA-Johnson Space Center/Flight Crew Support Division

DOD/OTHER AGENCIES: None.

FUTURE PLANS: The task network simulations developed will lead to a number of products that will be applied to future task networks simulations of the workload likely to be experienced during future missions. Specifically, the task network simulations will form the foundation for identifying overload conditions & developing strategies for reducing workload during space missions.

HUMAN WORKLOAD MODELING

TECHNOLOGY GOAL: To provide mission planners with a method for optimizing allocation of mission tasks; optimizing formulation of timelines, schedules and equipment design; and assessment of the feasibility of proposed missions.



A deformation will be made of the degree to which the task network model is a reasonable representation of the amount of workload likely to be induced by the task selected for analysis.

A total of 10 subjects from the aerospace community will be presented with a description of an EVA/IVA task in random order for each of the four workload channels. For each task, subjects will be assigned a numerical estimate that reflects the amount of workload likely to imposed by the task. Similar estimates will then be made for subsequent tasks.

Development of the model will involve translation of the operational sequence diagrams into a computer simulation that permits anlysis of the workload likely to be induced by the operation.

During this phase, a mission operation will be selected for analysis. The selecton process will begin with an in-depth examination of relevant documentation. The approach will ensure efficient extraction of task information and will establish the organization of the task analysis, as well as the functional flow of the task to be modeled. analysis of the operations performed will be completed in the form of operatonal sequence diagrams illustrating the steps that crewmembers must accomplish to complete the operation.

Background

The Human Workload Analysis program of investigation is a joint effort between NASA/Johnson Space Center and Brooks AFB. The center of overall responsiblity for the implementation of the project is the Crew Interface and Analysis Section of the Flight Crew Support Division of NASA-JSC.

Major Milestones

USAF Cooperative/Human Workload Analysis Project is a 3-year, 4-phase program of investigation.

FY95 - Front-End Analysis
FY96 - Workload Component Scale Development
FY97 - Execution and Model Validation

Management Approach

The NASA-JSC principal Investigator, in conjunction with the Human Interfaces Department at Lockheed Engineering and Sciences Co. (LESC), supports the overall effort for JSC. The Principal Investigator will report directly to the Flight Crew Support Division. Under the direction of the NASA-JSC Technical Monitor, the Engineering Supervisor of the Human Factors and Ergonomics Laboratory (HFEL) and the human workload analysis lead will be responsible for completion of all deliverables.

Technical support is provided by Brooks AFB, Armstrong Laboratories, in the form of implementing the workload models in computer models. The Air Force provides expertise in workload modeling using SAINT, a network analysis tool This predicts workload on any of several channels. The AF has expertise in programming in SAINT, and takes the models developed by NASA and implements them. The programs are transmitted electronically to be run on NASA equipment.

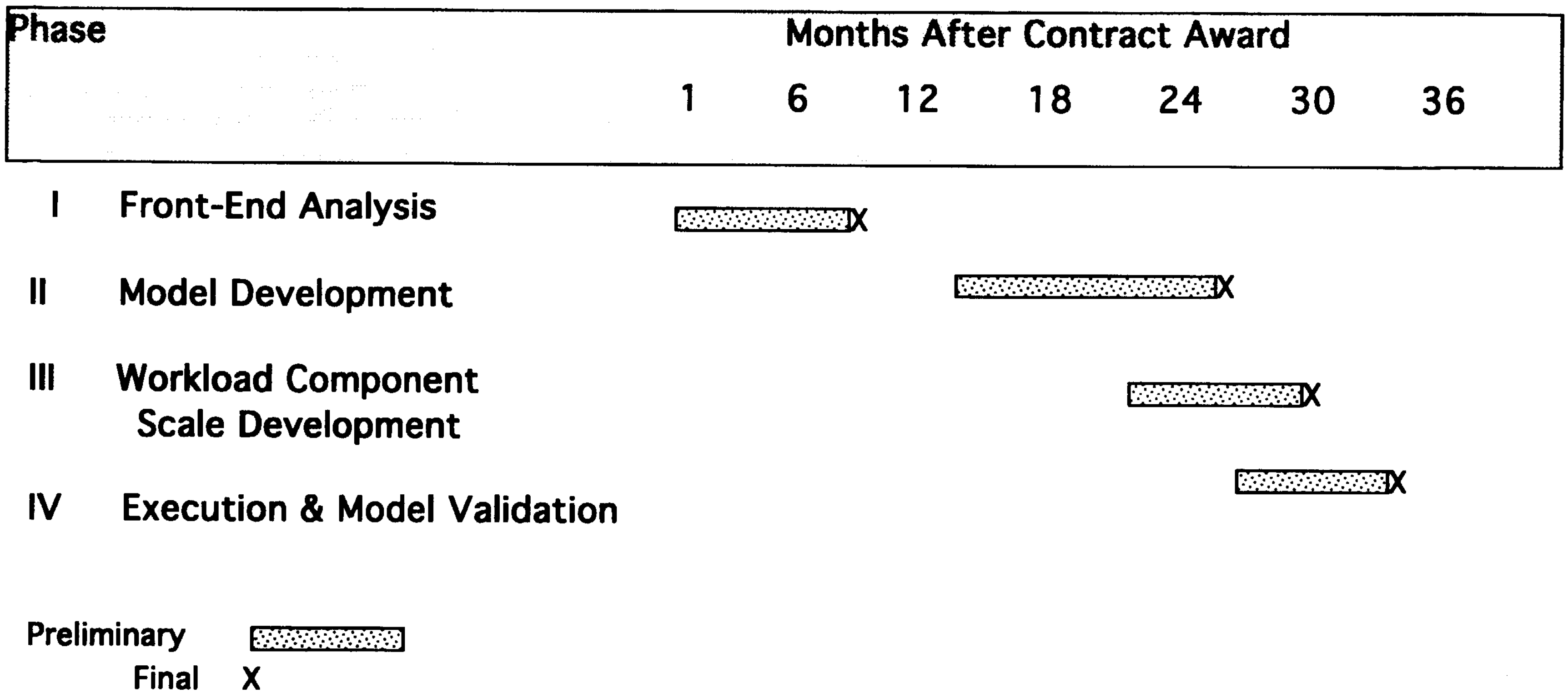
The project is managed by the NASA technical manager, with Lt. Mitcha providing Air Force management of budget, manpower, and work as assigned by NASA. All funding comes from NASA's Office of Life and Microgravity Science and Applications, and funds are transferred to the Air Force to cover their efforts.

End Products/Users

The task network workload modeling tool currently under development will provide mission planners with a method for :

1) optimizing allocation of mission tasks,
2) optimizing formulation of timelines and schedules
3) optimizing equipment design, and
4) assessment of the feasibility of proposed missions

Major Deliverable And Periods Of Performance



MATHEMATICAL MODELS OF DECOMPRESSION SICKNESS

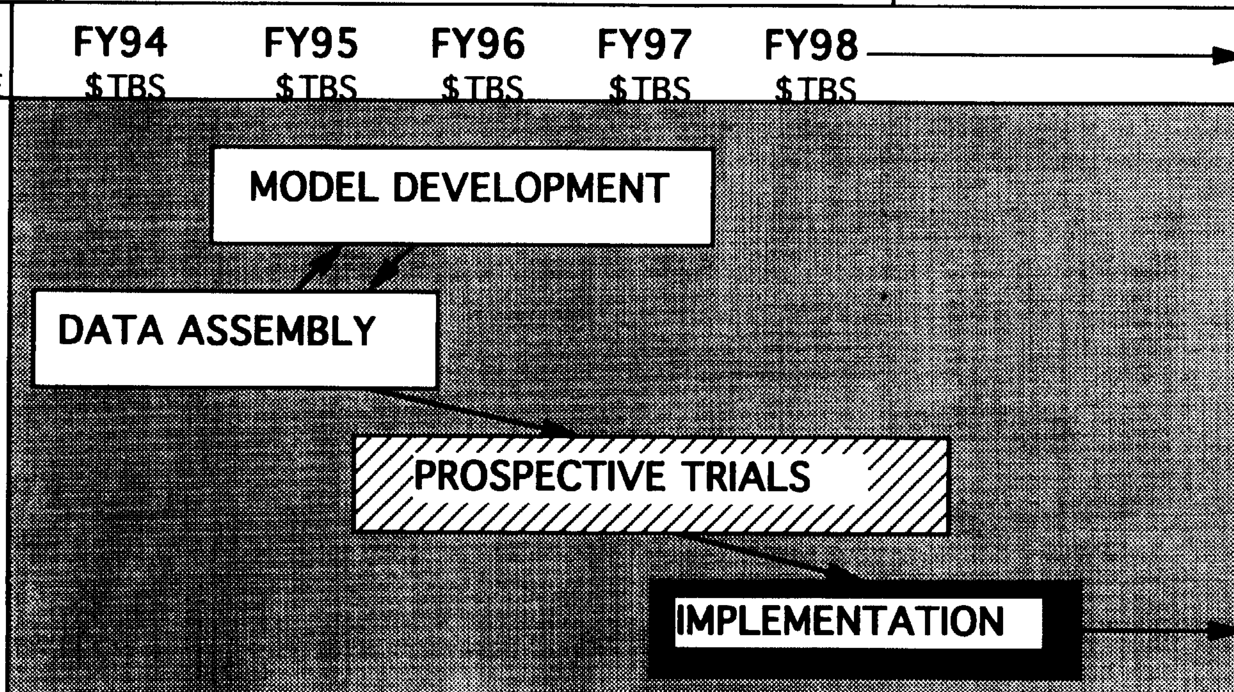
VISION: Calculate Decompression Schedules Without The Need For Involved Testing.

OBJECTIVE: Develop A Mathematical Model To Describe Results Of Decompression Experiments.

TECHNOLOGY AREA: Environ. Physiology

DISCIPLINE: Life Sciences

INVOLVEMENT					
NASA	AF	ARMY	NAVY	ARPA	DOE
X	X		X		
X	X		X		
X	X		X		



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Mr. James Waligora/Code SD5
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Other:

Carter Alexander
713/244-2027

NASA CENTERS: NASA-Johnson Space Center, Houston, Texas

DOD/OTHER AGENCIES: Brooks Air Force Base, Texas;Naval Medical Research Institute,MD

FUTURE PLANS:

ROLE OF EXERCISE IN ALTITUDE DECOMPRESSION SICKNESS

VISION: Understanding of the role of exercise and simulated microgravity in the etiology of decompression sickness.

OBJECTIVE: Improve the operational methods to reduce in-flight decompression sickness.

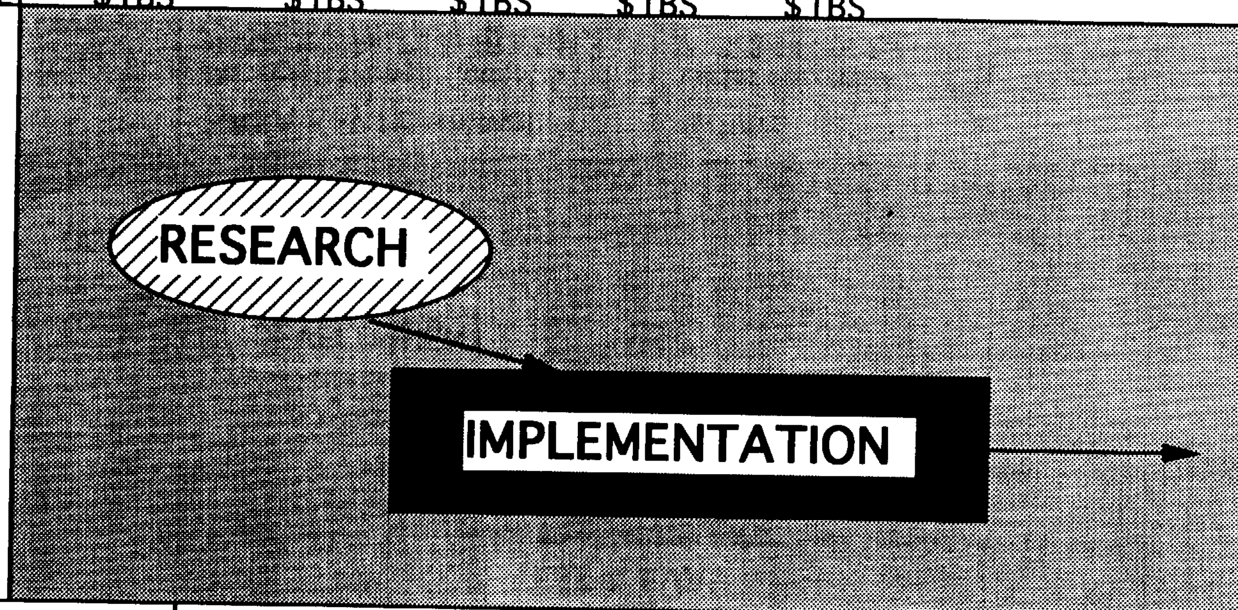
TECHNOLOGY AREA: Environ. Physiology

DISCIPLINE: Life Sciences

INVOLVEMENT

NASA	AF	ARMY	NAVY	ARPA	DOE
X	X				
X	X				

FY94	FY95	FY96	FY97	FY98
$TBS	$TBS	$TBS	$TBS	$TBS



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FUTURE PLANS:

ULTRASOUND BUBBLE DETECTOR

VISION: Provide rapid access to low pressure environments.

OBJECTIVE: Monitor decompression sickness.
Allow safe access to low pressure without long oxygen prebreathe.

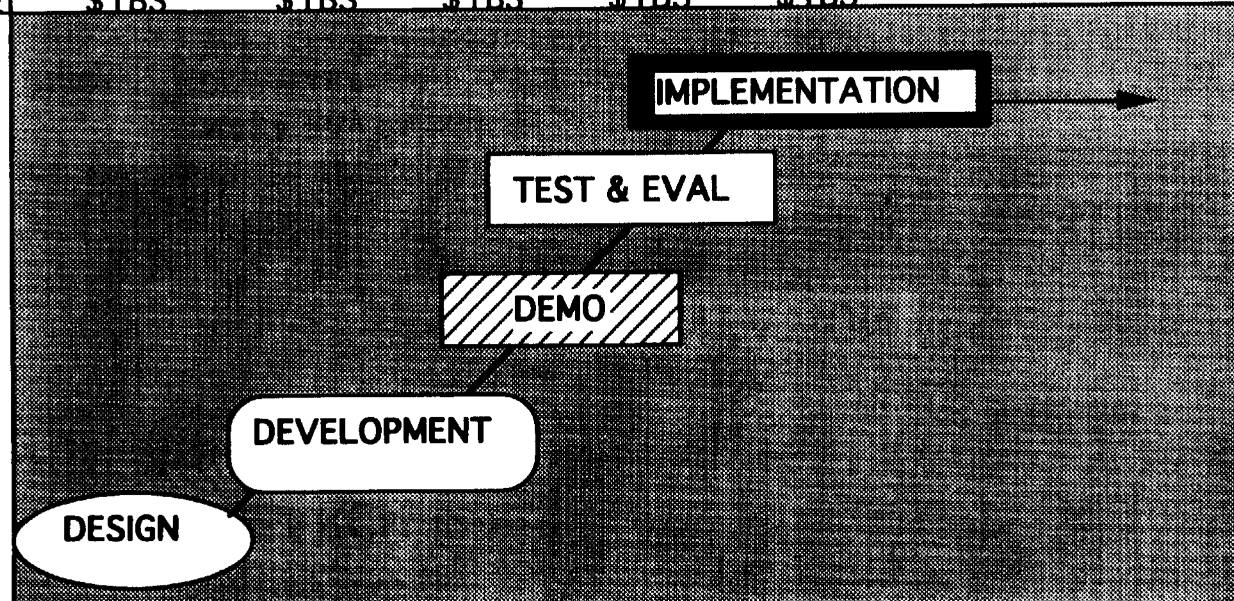
TECHNOLOGY AREA: Environ. Physiology

DISCIPLINE: Life Sciences

INVOLVEMENT

NASA	AF	ARMY	NAVY	ARPA	DOE
X	X				
X	X				
X	X				
X	X				
X	X				

FY94	FY95	FY96	FY97	FY98
$TBS	$TBS	$TBS	$TBS	$TBS



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